CDM Camp Dresser & McKee

City of Santa Fe

Water Supply Analysis for the City of Santa Fe

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Report

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Section 1
Introduction

1.1 Water Planning Needs in Santa Fe

Limitations in Santa Fe's ability to meet existing water demands became evident to the community in the droughts experienced in 1996 and 2000. While the effects of that drought were mitigated by intensive and mandatory conservation measures, the system's constraints were highlighted. With the existing supply infrastructure and rights, Santa Fe is immediately vulnerable to similar or more extended drought conditions. Future growth in population and water demands, as outlined in the City of Santa Fe's (City's) General Plan, will only intensify the need for increased water supply capabilities.

The City's Sangre de Cristo Water Division (SDCW) has developed this Water Supply Analysis to support development of a sustained water resource strategy in subsequent planning efforts. The City is working towards developing a strategy that provides the needed infrastructure in a cost-effective and environmentally sound manner. This approach will provide Santa Fe and the surrounding metro area with a more sustainable approach in the use of its water resources. Current limitations and increasing demands over time will require a combination of development of new sources of water and more efficient use of existing supplies.

The City purchased SDCW from Public Service Company of New Mexico (PNM) Water Services on July 3, 1995, and will gradually transition to operation of the system from PNM. PNM has remained on contract for operation of the system during this transition period. The transition to full City operation will be completed by June 30, 2001. The City recognizes the need to plan for future conditions to ensure its ability to provide the necessary water to the community over the long-term. A detailed 40-Year Water Plan must be developed to provide a road map for the City's future water supply. This report pulls together the data and outlines the problems facing the City. The City is embarking on a detailed analysis of all water supply alternatives beginning in 2001.

1.2 Key Issues Related to Water Planning for the Santa Fe Area

The City recognizes that water planning, especially in the arid southwest, involves many important decisions that can have wide-ranging effects. To effectively plan for and meet long-term water supply needs, the City will consider the following key issues.

1.2.1 Regional Planning and Partnerships

The City is working to develop agreements with Santa Fe County and surrounding communities to develop an effective regional water management plan. While the City's water plan will focus primarily on the needs of the City, it is intended to have the flexibility to be able to be wrapped into a larger regional plan. By working together, instead of in competition, Santa Fe and its neighbors can develop water supply, treatment, and distribution solutions that are cost-effective and strive towards sustainability. The City is seeking to maximize water use efficiency (conservation, water reuse, and drought management) and develop San Juan/Chama project water as "imported supply" as a strategy to maximize the community's local sustainable water resources in order to minimize the need to compete for scarce regional water resources, including environmental, agricultural, traditional, and historic uses.

The City's first regional partnership is already underway. The City is constructing a pilot test raw water diversion project in cooperation with Santa Fe County and the San Ildefonso Pueblo. The pilot test collector well, which is being constructed on the Pueblo's lands adjacent to the Rio Grande, could become part of a series of permanent collector wells to divert water for potable use in the City and the region. The City is also exploring other potential diversion sites.

The City is one of the sponsoring entities in the development of a "Regional Water Plan" through a grant program administered by the New Mexico Interstate Stream Commission for the regional organization called the Jemez y Sangre Water Planning Council. This process will evaluate regional supply versus demand and determine the public welfare issues of concern. The plan will become an integral part of the state Water Plan but will identify issues unique to the Santa Fe/Española area.

1.2.2 Watershed-Based Planning

The health of the entire Santa Fe watershed is critical to maintaining a high quality source of water. Efforts are underway to restore the upper Santa Fe River watershed to reduce the risk of a catastrophic crown fire and subsequent erosion by developing a thinning program with prescribed burn treatments. The use of treated wastewater effluent to augment the Santa Fe River and Rio Grande water resources to be considered under the 40-Year Water Plan is consistent with the goal to plan the region's water resources on a more "holistic," watershed-based level.

It is essential that the City develop a prioritized community and watershed-based ecologically-sound water supply plan that meets both the near and long-term demands of the community. This plan needs to consider benefit cost analysis, priority-phased implementation, and funding schedules. It must also address environmental impacts, incorporate drought planning management, and fit within the larger regional context.

1.2.3 Acequias and other Senior Water Rights

The City of Santa Fe must recognize senior water rights of surrounding Pueblos, acequias, and community wells through regional planning. Any analysis of water use components must consider the impacts to acequias and other senior rights and the possibilities for offsetting those impacts.

1.2.4 Funding Strategies

Clearly, an increased future supply of water will be associated with significant costs. The City and its regional partners intend to implement funding strategies that provide for new infrastructure through federal, state, local, and private partnerships. Other mechanisms, such as utility expansion charges, will be viewed as potential sources for the local cost share portion of federal dollars. Sustainable water resources are economically attractive; and in contrast, purchasing additional imported water rights and constructing the conveyance to retrieve them is cost-intensive.

The City has already pursued and received federal funds under cost-share agreements for implementation of some of the infrastructure needed to meet the area's long-term water needs. These funds were authorized under the U.S. Bureau of Reclamation's Title XVI program for reclaimed water, as well as VA-HUD and EPA programs. This plan does not develop costs or detailed funding strategies for the necessary improvements. However, it is important to recognize the funding needs that will arise, and to consider funding mechanisms and strategies throughout the development and implementation of the plan.

1.2.5 Phased Implementation

Implementation of new sources of raw water, infrastructure, and operational management practices will occur in phases over time that are tied in part to increases in demand. As an example, the pilot diversion system presently under construction represents a modular approach to building a full-scale system of diversion structures. Likewise, construction of treated effluent pipelines is expected to be conducted in phases to help augment the region's water supply needs as demands increase.

1.3 Previous Studies and Water Planning Efforts

The water planning effort builds on recent efforts conducted by the City and SDCW. Recognizing the limitations in local water supplies, the City, PNM, and Santa Fe County conducted a "Feasibility Study for Rio Grande Diversion System" (Boyle 1997). This study developed infrastructure alternatives for diversion of non-native water from the Rio Grande. It did not evaluate water demands or projected shortages in detail. The selected alternative identifies horizontal collection wells as the best technology to provide new diversions. The extent and method that that technology can be incorporated into the City or regional water system is discussed in this report.

In a separate effort, the City evaluated alternatives for increased use of treated effluent from the wastewater treatment plant (WWTP). Treated effluent has been used in Santa Fe for decades, but such water reuse has not been optimized to date. The Treated Effluent Management Plan (CDM 1998) identified water supply augmentation of the Santa Fe River and Rio Grande as the most attractive uses for an expanded effluent use program in Santa Fe. Thus, treated effluent will be a significant component of the City's sustainable water management program, and the planned uses of treated effluent must be incorporated directly into a 40-Year Water Plan.

Finally, the City's General Land Use Plan (April 1999) provides a basic policy and planning guidance for all facets of the City through 2020. The General Plan was used in the development of this report, particularly in the areas of population projection and other basic policy assumptions and decisions.

1.4 Goals, Approach, and Organization of the Water Supply Analysis

This report assesses the City's current water supplies and demands, and develops water management components for meeting long-term demands for consideration. This plan represents a significant change from the current water strategy by shifting to a sustainable approach to water resources management over time. Among the sources of water presently used by SDCW and others in a non-sustainable manner is groundwater from the aquifer underlying the City. Withdrawals from this aquifer outpace the rate of recharge to it locally, resulting in so-called "mining" of this resource in the vicinity of the City wells.

Section 2 of this report analyzes the City's current water supply capacities, focusing on the limitations associated with each supply source. In Section 3, historical water demands are examined, and projections for demands over the 40-year planning period are developed. Potential components of the City's plan to address the projected shortfalls in water supply capacity are discussed in Section 4.

1.5 Summary of Findings

The City of Santa Fe uses a combination of surface and groundwater supplies to meet water demands in its service area. The City's ability to supply water is limited by a number of factors, such as:

- Water rights for each of its sources (Santa Fe River, City Wells, and offsetting rights required to utilize San Juan-Chama contract water)
- Snowpack and runoff in the Santa Fe River watershed
- Well infrastructure
- Conveyance infrastructure
- Sustainable use of supplies

This Water Supply Analysis considers the existing constraints and compares existing water supply capacities to projections of potential urban and regional demands over the next 40 years.

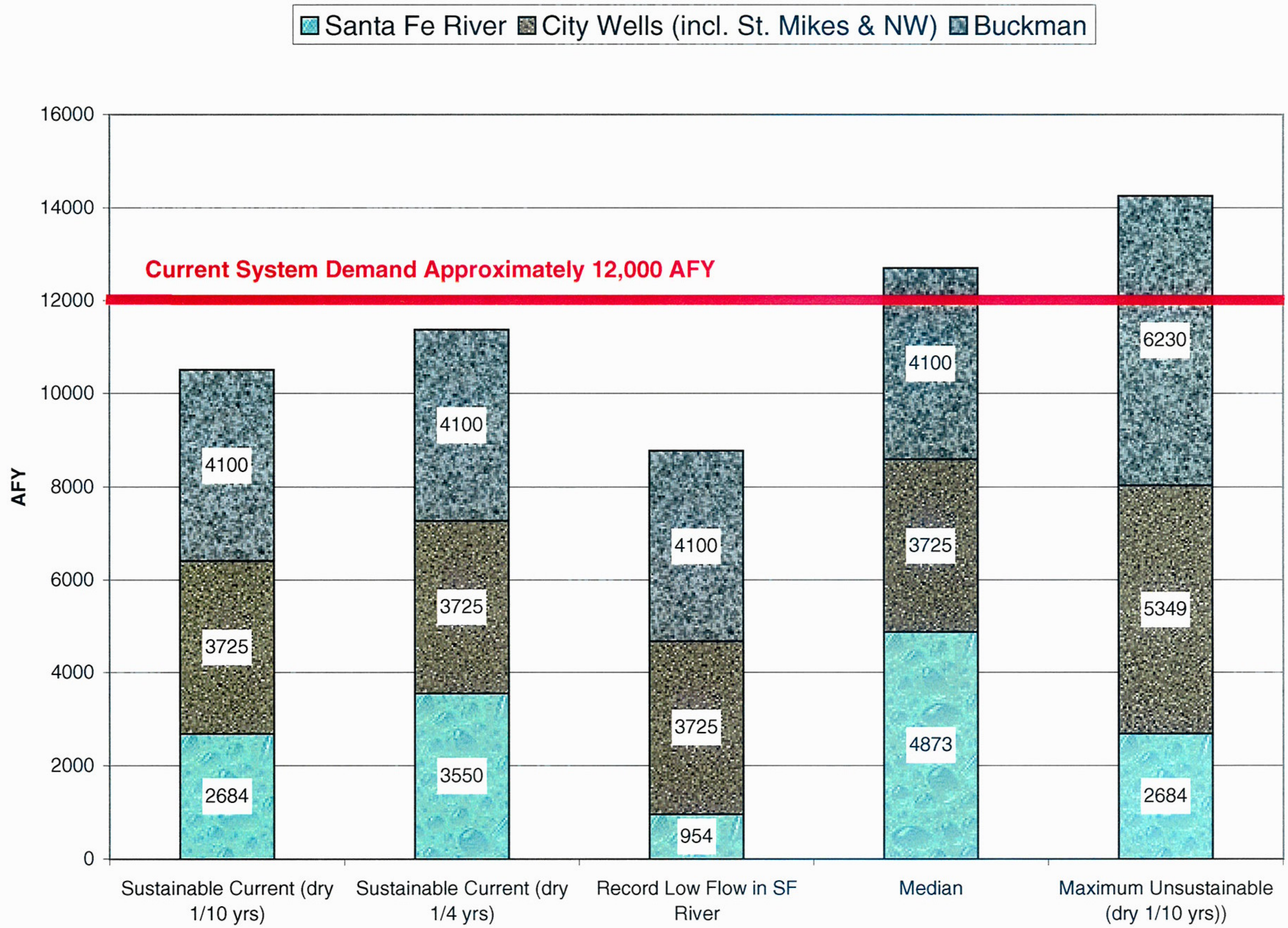
Previous investigations yielded estimates of "sustainable" levels of use for the City's existing infrastructure and practices in its Buckman Well Field and City Well Field at 5,000 acre-feet per year (AFY) and 3,725 AFY, respectively. Sustainability refers to the point at which withdrawals are equal to or less than the rate of water recharge to the wellfield.

Figure 1-1 depicts the City's existing annual supply capacity under a variety of water supply planning scenarios, including:

- Sustainable use, under 1-in-10 year drought conditions on the Santa Fe River
- Sustainable use, under 1-in-4 year drought conditions on the Santa Fe River
- Sustainable use, under record low flow conditions on the Santa Fe River
- Sustainable use, under median flow conditions on the Santa Fe River
- Maximum unsustainable use, under 1-in-10 year drought conditions on the Santa Fe River

Sustainable Buckman use shown as 4,100 AFY in Figure 1-1 is reflective of the fact that the City has commitments to supply water to Las Campanas and Santa Fe County (per agreements with the City) that are withdrawn from this source, currently estimated at 900 AFY.

Comparison of current demands of about 12,000 AFY to these planning scenarios suggests that the City's current ability to meet demands in dry years is marginal, as shown on Figure 1-1. Actual use in 2000 was about 11,300 AFY, reflecting significant demand reduction measures that were implemented to address drought conditions. By 2020, urban area demands could range from 15,000 to 16,100 AFY, and regional demands could range from 17,500 to 18,000 AFY. By 2040, urban demands could reach 18,800 to 21,000 AFY, and regional demands could range from 23,700 to 24,300 AFY. Clearly, one or more of the supply constraints listed above must be addressed if future demands are to be met. Section 4 of this report presents some of the considerations in addressing these constraints, including potential means of increasing the City's ability to meet its growing water demands.



CDM Camp Dresser & McKee Inc.
SDCW Diversions Historical.xls Fig 2-23

Figure 1-1
Current Annual Supply Capacity of Sangre de Cristo Water

Section 2
Existing Water Supplies

2.1 Overview of Existing Sources of Supply

Raw water in Santa Fe is obtained from multiple sources, forming a supply and delivery system that has evolved over time as the City's service base grew and constraints on local sources became more evident. This section provides a general description of the City's sources of supply. Water rights and agreements associated with each source, as well as other details on the types and constraints of each supply source, are discussed in subsequent parts of Section 2. The City's three primary sources of supply today include:

- Surface water from the Santa Fe River watershed
- Groundwater from the City Well Field along the Santa Fe River
- Imported water from the Buckman Well Field near the Rio Grande

These are depicted graphically in Figure 2-1, as are other potential supply sources that are discussed in this section.

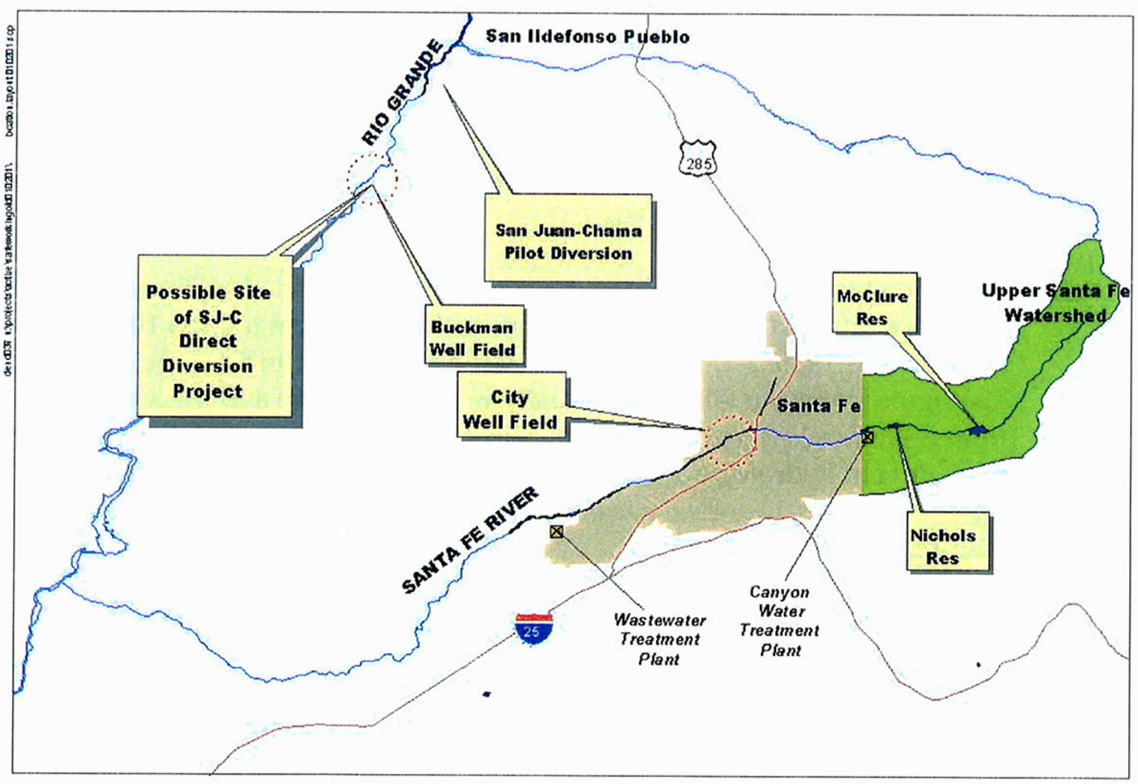


Figure 2-1 Santa Fe Raw Water Supply Sources

Water use in Santa Fe has been documented dating back several centuries. The City's first designated water right was established on the Santa Fe River with an 1880 priority date. Because the Santa Fe River travels through the heart of the historical parts of the City, it has been a source of supply for hundreds of years and continues to provide an essential piece of the City's water resources today. The City's Santa Fe River surface water supply is generated by the upper Santa Fe River watershed, consisting primarily of mountain runoff from the Sangre de Cristo mountains. To maximize the ability to draw on this resource, reservoirs have been constructed on the river in the canyon above town, located in the upper portion of the watershed. Details of these reservoirs are provided in Section 2.3. The yield is variable, depending on each year's rainfall and snowpack. The City's Canyon Road potable water treatment plant (WTP) is located downstream from the reservoirs where it treats the water from the two reservoirs.

The drought conditions Santa Fe experienced throughout the 1950s affected water planning and management in the City as well as the region. Recognizing the growth in water demands, and the inability of the Santa Fe River source to meet those demands in drier years, the City drilled several potable supply wells in the early 1950s. These wells are located near the Santa Fe River in central Santa Fe. Details of the so-called "City Well Field" are provided in Section 2.4.

As demand for water continued to grow, Santa Fe began importing water from the Buckman Well Field near the Rio Grande in the 1970s. This supply source is discussed in detail in Section 2.5. The City presently uses San Juan-Chama (SJC) contract water to offset the effects of Buckman pumping on the Rio Grande streamflow.

Today, the SDCW distribution system is served by all three of these sources of water supply. The combined production from these sources barely meets current water demands. Without additional sources, the existing sources must be managed with efficiency and careful planning.

Santa Fe's historic use of each of these sources is illustrated in Figure 2-2. Average withdrawals and minimum yields from each source over the last 10 years are presented in Table 2-1. In evaluating past uses of water in Santa Fe, it is important to distinguish between what was actually withdrawn (use) and the amount available from each source (yield). The City's prioritization of water supplies used each year is a function of hydrologic, economic, and operational factors that cannot be directly interpreted from historical use data. Actual yields in any given year may be higher than the amount used.

2.2 Water Rights Owned by the City of Santa Fe

2.2.1 Introduction

Santa Fe holds water rights on two local ("in-basin") sources of supply, including surface water in the Santa Fe River and groundwater in the underlying aquifer. Local surface water is stored in McClure and Nichols Reservoirs above town (the "canyon reservoirs"). Local groundwater is drawn from several wells that make up the City Well Field in town.

Table 2-1 Historic Source Uses

Source	10-Year Average Withdrawal, 1990-1999 (AFY)	Avg. % of Total Supply, 1990-1999	Minimum Withdrawal, 1990-1999 (AFY)	10th Percentile (Low) Withdrawal over POR (AFY) [1]
Santa Fe River	4,637	39.2	2,682	1,985 (1948-1999)
St. Michael's Well	215	1.8	32	22 (1961-1999)
City Wells	2,051	17.4	1,024	413 (1950-1999)
Buckman Wells	4,911	41.6	3,186	510 (1972-1999)

1 90% of all values are above the listed value over the period of record (POR). POR for each source shown in parentheses.

AFY acre-feet per year

In the 1970s, as the inability of available local supplies to meet increasing demands became evident, the City began importing water to supplement local supplies. Imported water is withdrawn from the Buckman Well Field west of town, near the Rio Grande. The City has a permit to withdraw up to 10,000 acre-feet per year (AFY) from the Buckman Wells, but must provide offsetting water rights to use this water. A significant amount of offsetting water rights is available to the City via its SJC contract water. A summary of the City's water rights holdings is provided in Table 2-2. The City also has the ability to use treated wastewater effluent to satisfy a portion of its water demands. The amount of effluent that can be used depends in part on whether the effluent is of local or imported origin. Water rights issues related to treated effluent are discussed in Section 2.2.6.

Table 2-2 Summary of City of Santa Fe Diversion Water Rights

Category/Name of Rights	Amount (AFY)	Priority Date	Type of Instrument
Local Water			
Santa Fe River and Reservoirs	1,540	1880	Declaration No. 1278
Santa Fe River, Reservoirs, and St. Michael's Well	3,500	1925	License No. 1677
Santa Fe (City) Well Field	4,865	1946 - 1951	Permit Nos. RG-1113 to RG-1118
Imported Water			
Buckman Wells	10,000 [1]	1976	Permit No. RG-20516

1 Permitted quantity (diversion right). Use of permit requires partial offsetting water rights. The City uses SJC and native Rio Grande rights (currently totaling 5,736 AFY consumptive) to provide the offset on the Rio Grande.

A full listing of all City water rights holdings, including Rio Grande tributary offsets and other supplementary data, is included in Appendix C.

2.2.2 Local Water

Local water is the water obtained from the Santa Fe River and the aquifer beneath the City of Santa Fe. Table 2-2 lists the local water rights held by the SDCW.

Figure 2-1 shows the approximate location of the diversion points on the Santa Fe River and wells.

2.2.2.1 Santa Fe River (Declaration 01278 and License 1677)

The City's existing surface water right is limited to 5,040 AFY. The reservoir rights are stored in Nichols and McClure Reservoirs east of the City. License No. 1677 allows a combined surface water and groundwater diversion of 3,500 AFY, with storage not to exceed 3,500 acre-feet (AF) in McClure and Nichols Reservoirs. The State Engineer approved the transfer of 500 AF of storage rights from Two Mile Reservoir to McClure Reservoir when Two Mile Reservoir was removed, bringing the total allowable storage in these reservoirs to 4,000 AF. The groundwater component is St. Michael's well (File No. RG-304), which allows a maximum pumping rate of 1,000 gallons per minute (gpm). As presently equipped, the St. Michael's well can produce a maximum of about 700 AFY (if operated 11 months per year). This well is supplemental to the surface supply.

Storage of water in the reservoirs is controlled in part by the Rio Grande Compact. The Rio Grande Compact, entered into by the States of Colorado, New Mexico, and Texas, is administered to include all of the territory drained by the Rio Grande and its tributaries. Administration is accomplished through scheduled delivery obligations. Storage in Nichols and McClure Reservoirs is subject to Article VII of the Compact, which bars the storage of water in reservoirs constructed after 1929 "whenever there is less than 400,000 AF of usable water in project storage," except for 1,061 AF of storage capacity in McClure (because it and Two Mile Reservoir were constructed prior to 1929).

In the event that New Mexico is in debit status under the Compact and debit water is stored in Nichols or McClure Reservoir, that debit water is subject to call by Texas. To date, there has not been a physical release of stored water from the Santa Fe Reservoirs under a priority call under the Compact. In the past, the City has obtained permission from the Office of the State Engineer (OSE) to satisfy such calls by releasing SJC water from storage in the Rio Grande system rather than making releases from the Santa Fe River reservoir system. This may represent a more practical approach, since any calls for water from the Santa Fe River reservoirs would be unlikely to reach the Rio Grande due to the significant infiltration that occurs in the Santa Fe River as it travels through town and towards the Rio Grande.

In addition, a small city right of 0.54 AFY on Acequia del Llano is near the water treatment plant on Upper Canyon Road.

2.2.2.2 City Well Field (Permits RG-1113 through RG-1118)

Water rights associated with seven City Wells (Figure 2-3) under permits RG-1113 through 1118 amount to 4,865 AFY. Well rights are located in an area extending from downtown Santa Fe southwest to near Baca Street and are generally close to the Santa Fe River. Because of deficiencies in the wells, and because of aquifer pollution, the City has not yet made full use of the water right. The City Well Field is shown on Figure 2-3.

The City has small quantities of additional water rights in the Santa Fe Basin as follows:

- 25.06 AFY from the Osage well at a rate up to 500 gpm
- 54.62 AFY from a well at the Acres Estates Subdivision
- 3.3 AFY associated with Country Club Estates
- 3 AFY at the municipal airport

Except for the Osage well, the other minor rights have not been directly exercised into the municipal system. The City plans to apply for a permit to aggregate these rights into existing points of diversion in the near future.

2.2.3 Imported Water - Buckman Wells and San Juan-Chama Project

Table 2-2 lists the imported water rights held by SDCW. Figure 2-4 shows the location of the Buckman Wells.

The Buckman Wells are associated with several water rights. They are operated under a permit that allows a maximum pumping rate of 10,000 AFY. Impacts to the Rio Grande, the Rio Tesuque, and the Rio Pojoaque from pumping the Buckman Wells must be offset with existing water rights. Presently, the City uses SJC water to offset impacts to the Rio Grande. The amount of offset required each year is calculated by the OSE using the McAda-Wasiolek (1988) model.

The City holds significant water rights to offset the streamflow depletions caused by the pumping of the Buckman Wells. Offsets for mainstem Rio Grande depletions include 5,605 AFY (of which 375 AFY is from Santa Fe County's contract) from the SJC Project and 131 AFY of consumptive use rights that were obtained from Valley Utilities in Albuquerque. The City of Santa Fe and Santa Fe County together have SJC Contract rights of 5,605 AFY through December 31, 2016 with an option to renew. SJC water is stored in El Vado and Abiquiu Reservoirs for use in subsequent years because the primary contract with the Bureau of Reclamation does not allow carry-over storage in Heron Reservoir. Irrigation rights have been obtained in the Rio Pojoaque and Rio Tesuque drainage basins to offset depletions of tributary streams, as detailed in Appendix C. Las Campanas has an agreement to lease at least 1,200 AFY of Albuquerque SJC water, and can lease up to 1,600 AFY. This contract is up for renewal on December 31, 2011, with the option to renew for up to three additional 5-year periods if the City of Albuquerque doesn't need this water.

Estimates provided by SDCW indicate that the offset ratio for mainstem Rio Grande depletions has varied from approximately 0.12 to 0.48 over the last 10 years (1990-1999). In this offset ratio range, the City has more than sufficient Rio Grande offsets to pump the permitted 10,000 AFY from Buckman. Pojoaque and Tesuque offsetting rights have been adequate until now, but combined with Las Campanas rights will be sufficient until 2008 (see Appendix G). Continued pumping at Buckman will increase the tributary offset requirements. In this event, the City may be required to purchase and retire acequia rights to meet the offset requirements. These rights may not be available, now or in the future.

Two other factors restrict the City from pumping the full 10,000 AFY amount at this time, including inadequate well and conveyance infrastructure, and a recent finding that the Buckman Well Field cannot be operated sustainably at this high rate of withdrawal. The City has recently had to set the pumps deeper in two Buckman Wells to maintain their pumping capacity due to a dropping water table in the vicinity of the wells.

The offset ratio, as determined by modeling, is dependent on the cumulative historical quantity pumped from Buckman as well as the timing of the withdrawals. Even if pumping were to be suddenly discontinued, offset requirements would linger for many years, eventually tapering off to zero. If the City continues to pump from Buckman at a high rate, the offset ratio could in theory eventually reach one-to-one. At such a point in time, full diversion from Buckman would require more offsetting water than the City currently possesses, totaling 10,000 AFY. The likelihood of this scenario actually being realized is low, especially if the City elects to operate Buckman in a sustainable fashion (i.e., withdrawing 5,000 AFY or less, as discussed later).

The offset of impacts to the Rio Grande and tributaries is accomplished through a "dedication" process. Issues have been raised with respect to the legal propriety of the "dedication" procedure, which would directly impact the ability of SDCW to exercise the Buckman permit. The process of dedication was created administratively with the State Engineer's action on Permit No. 20516, et al. The statute does not authorize the process. The legal effect was to authorize the future transfer of tributary rights into the Buckman Well Field without affording existing water right owners the procedural due process embodied in the statutes with regard to each transfer.

The City of Santa Fe is presently in the process of exploring options of diverting SJC water more directly from the Rio Grande through horizontal infiltration galleries or direct diversion. The best hydrogeologic site for the infiltration gallery may be on San Ildefonso Pueblo as shown on Figure 2-1 (pilot test site). The infiltration galleries would be treated as a surface water right according to the State Engineer Office, but because the water is filtered through 35 feet of alluvial sediments, its water quality may prove adequate for designation as "groundwater" with respect to the EPA Surface Water Treatment Rule. Thus, it may require a lower level of treatment than would be required if it were considered to be "surface water." This will be confirmed in pilot studies currently underway.

2.2.4 Adjudication Issues

Two adjudications are underway that could impact the City of Santa Fe water rights; the Anaya (Anaya versus Public Service Company of NM, First Judicial District Cause

No. 43, 347) and the Aamodt (S. E. Reynolds versus Aamodt, DN.M. No. 6639-M Civil) Suits. The Anaya suit addresses the Santa Fe River and tributaries and the Aamodt suit includes the Tesuque-Nambe-Pojoaque Rivers and tributaries. The adjudications are intended to effectuate quiet title to the interrelated claims to the use of a given source of supply. The purpose is to determine all rights to the use of water and determine the amount of unappropriated water.

The Aamodt suit was filed in 1966 to adjudicate the water rights of all water users in the Rio Tesuque and Rio Nambe systems northwest of Santa Fe. The suit resulted in the joinder of approximately 1,000 non-Indian users as well as the Nambe, Tesuque, Pojoaque, and San Ildefonso Pueblos. The adjudication will control water usage in drainages immediately to the north of Santa Fe. Sangre de Cristo has rights in adjudicated subfiles intended to offset depletions caused by pumping the Buckman permit.

In 1985, the court held that under Spanish and Mexican law the Pueblos' water rights constituted prior and paramount rights to a sufficient quantity of water to meet the Pueblos' present and future needs. This meant that the needs of each citizen for domestic and sanitary water would first be met, and then the remaining water would be distributed based in part on priority and in part on need. The court concluded that the Pueblos have the right to use all of the water of the stream system necessary for their domestic needs, and to irrigate historically irrigated lands, with the exception of land and appurtenant water rights terminated by operation of the 1924 Pueblo Lands Act.

This priority applies to all acreage irrigated by the Pueblos between 1846 and 1924. Federal law including the Treaty of Guadalupe Hidalgo and the 1851 Trade and Intercourse Act protected acreage under irrigation in 1846. The 1924 Pueblo Lands Act fixed the amount of water that could be irrigated under this standard, which has become known as the "historically irrigated acreage." All physically interrelated groundwater is subject to the Pueblos' claims. The potential consequence of awards to the Pueblos for substantial claims is that SDCW's offset rights could be called out by the Pueblos or the Pueblos could seek compensation for not exercising their rights.

The Santa Fe River rights used by SDCW are subject to the Anaya suit. Other parties to this suit include rights held by Acequias Llano, Muralla, Madre, Cerro Gordo and rights held by the communities of La Cienega, La Bajada and Cochiti Pueblo. SDCW, prior to ownership by the City of Santa Fe, raised a "paramount" claim to water from the Santa Fe River. This claim would allow the City an expanding right to meet development as needed. The adjudication court is unlikely to recognize this claim. Judge Encinias' opinion in a 1990 case concerning the Acequias claim for prior water rights indicates that the City water rights will not be paramount. Judge Encinia wrote, "I believe that the preservation of these water rights is important to the vitality of a culture over three centuries old. The people, the land, and the water are inextricably bound together and will be until Santa Fe is entirely paved over. It is this culture which is our greatest pride and not without considerable value, though not measurable directly in dollars."

2.2.5 Agreements with Santa Fe County and Las Campanas

SDCW has contractual obligations to provide water service outside of the City's service area to the Santa Fe County Water Company and Las Campanas. A discussion of these obligations and associated operating criteria follows.

2.2.5.1 Santa Fe County Water Company

Potable water is delivered by SDCW to the Santa Fe County Water Company (SFCWC), a utility owned by Santa Fe County, at three transfer meter locations (i.e., delivery points). Three long-term delivery agreements dictate the operation, maintenance, and billing by the two parties for the transfer of water:

- Agreement to Deliver Water, dated August 10, 1994
- Memorandum of Understanding, dated October 26, 1994
- Cost-Sharing Agreement for Water Delivery Facilities, dated June 28, 1995

Santa Fe County has contract rights to 375 AFY of SJC water; up to 500 AFY of water can be delivered to SFCWC when conditions allow. SDCW produces this water through the Buckman Wells, wheels the water over the distribution system, and delivers the water at SDCW system pressures to the SFCWC water system at the transfer meter locations. The duration of the delivery agreement is 10 years, beginning July 1, 1995. At year 5 of this agreement, the fee structure can be revisited.

The original agreements contain two delivery points, and a third delivery point was later approved by City Council action. The first delivery point is located south of I-25 on the west side of Richard's Avenue, and the second is on the west side of Cerrillos Road across from the Santa Fe Factory Stores. These two original transfer points are capable of transferring 3,500 gpm. These two transfer meters were designed to support large commercial fire flows on the SFCWC system including the New Mexico State Penitentiary and the National Guard complex. The third delivery point is located at the south end of Las Campanas Estates I and II. It is capable of transferring 1,500 gpm, sized to provide residential fire flow.

2.2.5.2 Las Campanas

Theoretically, Las Campanas uses its own water rights and contract water. SDCW does not use any of its water rights or contract water to supply Las Campanas. The agreements between these entities are strictly for service and use of SDCW's infrastructure. However, the accounting of the required offset by the Interstate Stream Commission (ISC) has been placed solely on Sangre de Cristo. The City is working with ISC staff to correct the accounting procedure.

In 1987, Las Campanas (formerly known as Santa Fe County Ranch Resort) entered into a long-term lease for use of specific SDCW facilities. The lease and operations are in these two documents:

- Lease of Water Facilities, dated August 5, 1987
- Management Agreement for Leased Buckman Facilities, dated August 5, 1987

The agreements between SDCW and Las Campanas specify that water shall be delivered to Las Campanas at flow rates not to exceed either:

- 50 percent of the flowrates produced from Buckman Well Nos. 3 to 6

- 25 percent of the flowrate produced from Pump Nos. 1 and 2 at Buckman Booster Station Nos. 1 to 4

or 1,600 AFY in any year. Delivery is limited to production and/or transportation capabilities of the leased facilities or due to drought conditions.

Las Campanas leases 50 percent of the production from Buckman Well Nos. 3 to 6 and pays for the operations and maintenance based on their share of the water produced and 50 percent of capital improvement costs.

It also leases 25 percent of the pumping capacity from Pump Nos. 1 and 2 at Buckman Booster Station Nos. 1 to 4 (1,275 gpm) and pays for the operations and maintenance based on their share of the water pumped and 25 percent of capital improvement costs.

Las Campanas leases the facilities to pump up to 1,600 AFY of water through the leased facilities and calls for water as required. Delivery of water is made at three points to Las Campanas. The two primary delivery points are at the Golf Course diversion point and at the Domestic diversion point. Las Campanas delivery is reduced to the degree that malfunctions in leased facilities reduce production and transport.

In 1999, the City of Santa Fe provided almost 900 AFY to Las Companas. Given that the sustainable production from the Buckman Well Field is 5,000 AFY, the amount available to the City is currently about 4,100 AFY.

2.2.6 Treated Effluent

Treated effluent forms a key component of Santa Fe's long-term water supply. However, its use is subject to water rights constraints, much like any other source of water. Water rights issues related to treated effluent are described below.

2.2.6.1 Overview

Effluent from the City of Santa Fe's WWTP has been utilized for irrigation of pasture, field crops, and orchards since 1941. As with all water resources in the southwestern U.S., there are water rights considerations associated with the use of treated effluent. A thorough evaluation of water rights issues related to effluent use was developed in the City's Treated Effluent Management Plan (TEMP, CDM 1998). A summary of key findings from that evaluation is provided here.

The source of the water is particularly important when considering options for using treated effluent. Effluent can be classified according to the type of water supply from which it originates, e.g., there is *local effluent* and *imported effluent*. From a legal perspective, the key consideration is that reuse increases the amount of water that is consumed by a city. The documents that define any city's water rights sometimes state the quantity of water that may be consumed (depleted), and sometimes they simply specify the amount of water that may be diverted and say nothing about consumption. In the first case, a city may deplete whatever amount of water is provided for in the water-rights document; reuse is clearly allowed. In the second case, the amount of water that can be consumed is potentially uncertain; the ability to reuse water may be in question.

Santa Fe's rights to import water are defined in terms that allow the City to consume 100 percent of what it diverts.

In contrast, Santa Fe's rights to take water from the Santa Fe River and to pump water from the local aquifer do not state how much water may be consumed. Thus, there is a potential question about whether reuse of local effluent is legal. However, the TEMP concluded that a decision by the New Mexico Supreme Court (S.E. Reynolds versus City of Roswell, 99 N.M. 84, 654 P.2d 537, 540, 1982, commonly known as "City of Roswell") gives the City a firm basis for claiming an entitlement to reuse all of its local effluent. The City's expectation is that this ownership will be affirmed in the current adjudication of the Santa Fe River, the Anaya case. Under current State of New Mexico practices, only imported effluent is eligible for a Return Flow Credit. This suggests that local effluent is the preferred source for other reuse/water supply alternatives.

2.2.6.2 Quantification of Effluent Water Rights

It is important to separately quantify the City's local effluent and its imported effluent for two reasons: under current practices, the State Engineer will give a Return Flow Credit only for imported effluent returned to the Rio Grande for credit; and the ownership of local effluent, while reasonably secure, is not yet affirmed by the Anaya Court. About 60 percent of all of Santa Fe's diversions end up as sewage that flows into the City's WWTP, varying from year to year and month to month. In the absence of any data or policy directives from the State Engineer, it is assumed for purposes of this document that the 60 percent factor applies equally to local effluent and to imported effluent.

Discharges at the WWTP

There are nearly 100 acres of irrigation water rights located downstream of Santa Fe's WWTP on the Santa Fe River. The irrigation rights principally occur along acequias in the La Cienega and La Bajada communities. The City recognizes value from downstream uses of effluent for fish, wildlife, and riparian vegetation. However, under New Mexico law, such uses do not have a water right and are not protected. Any City decision to maintain flows for these uses would be based on considerations other than water rights. Considering the downstream irrigation uses and a desire to protect aquatic and riparian habitats, the TEMP concluded that an average baseline flow of approximately 3 million gallons per day (mgd), equal to 3,400 AFY, should be released to the river at the WWTP. This amount coincides with the approximate return flow requirements of the City's diversion of Santa Fe basin water.

Using Effluent to Obtain Return Flow Credit
One reuse option being pursued by the City is discharge of imported effluent to the Rio Grande in order to obtain a Return Flow Credit. The concept of a Return Flow Credit has been developed over the years as part of the administrative practice of the New Mexico State Engineer. There are no written rules, regulations, or guidelines for this practice. The nature of the practice is summarized below, based on the study of actual decisions on hundreds of municipal well permits.

The principle of a Return Flow Credit applies to imported water for the reason that the City's Rio Grande water rights are defined in terms of the amount of water that can be consumed or depleted. A return of water to the river reduces the depletion and allows the additional taking of water within the established right. The following relationship applies:

diversion allowed = quantity of depletion rights + quantity of return flow

An increase of return flow on the right side of the equation will increase the diversion quantity on the left side. The increase is one-for-one, that is for each AF of return flow that the State Engineer credits as reaching the original water source, he will allow an additional AF of diversion from that source.

The State Engineer presently recognizes no return of the City's imported effluent to the Rio Grande. Thus, today the City's limit on diversions is equal to the quantity of its depletion rights. Figure 2-5 shows how the City's diversions would increase if it had a Return Flow Credit.

Figure 2-5 indicates that for today's conditions, when there is zero Return Flow Credit, the City and County's combined 5,605 AFY (5,230 City only) of rights support a diversion of only 5,605 AFY of Rio Grande water. However, the same depletion right would support a diversion of almost 15,000 AFY if every drop of effluent from imported water were documented as returning to the Rio Grande (assuming 60% of water diverted is returned to the City's WWTP).

Actual Return Flow Credits are not likely to be as high as 60 percent because of losses during conveyance and because some imported effluent may be used elsewhere. In this document, it is assumed that diversions could increase to a maximum of 14,000 AFY, to be conservative. Nonetheless, this chart indicates the potential significance of a Return Flow Credit as a means of allowing Santa Fe to increase its diversions of imported water without having to acquire additional Rio Grande water rights.

2.2.7 Acequias

SDCW makes deliveries to acequias and special events occurring downstream from the reservoirs and WTP. These deliveries must be planned and coordinated by SDCW, making sure service to SDCW customers is not interrupted, with timely delivery to the acequia users.

Four Acequia Associations rely on Santa Fe River water as their source of irrigation water. The total water rights owned by the Acequia Associations is approximately 135 AFY. The Acequia water rights are senior to the City of Santa Fe's rights and must be satisfied prior to satisfying the City's rights. While the Associations have indicated verbally that they will share in any shortage, no formal agreements exist between them and the City. In either case, these demands must be included in the planning and operation of the SDCW system.

The acequias are overseen and used by associations that had been formed to divert the Santa Fe River water for irrigation from the upper canyon to as far away as the Agua Fria Village and farm area. The associations have legal status as holders of water rights in the Santa Fe River basin (based on court rulings from 1983) and the historical primacy of the acequias has been supported by the courts. The Acequia Madre also has the status of a preserved State Cultural Property. The Court has ordered these quantities be delivered to these three acecquias:

- Acequia Madre 65.31 AFY
- Acequia Cerro Gordo 8.00 AFY
- Acequia Llano 54.40 AFY

Court rulings have required the utility owner/operator to supply water to the acequias even under drought conditions. Methods have been developed to introduce water into the acequias at specific points from the distribution system infrastructure when upstream flows are inadequate.

2.3 Santa Fe River Supply

The Santa Fe River is Santa Fe's oldest source of municipal water supply. A description of this source of supply, along with constraints on its use and water production rates, is provided in this section.

2.3.1 Santa Fe River Watershed and Storage and Treatment Facilities

The Santa Fe River begins in the upper reaches of the watershed at Santa Fe Lake, a natural lake in the mountains above town. Downstream from the lake, the river picks up additional runoff from the watershed as it travels toward SDCW's two man-made potable water supply reservoirs. McClure Reservoir is located upstream of Nichols Reservoir. These reservoirs are used to store surface water from the river for delivery to four acequias and potable treatment at the Canyon Road WTP. Treated water is conveyed to SDCW customers in the community in the SDCW distribution system.

The Santa Fe River is usually the City's first choice of water supply due to its high quality and "renewable" nature. However, drought conditions such as those experienced in 1996 can severely limit the availability of this surface water. Surface water treatment is more rigorous and expensive than groundwater treatment, as regulated by EPA and New Mexico Environment Department (NMED). Costs for treatment of surface water supplied continue to increase. The proximity of this source to town and the ability to deliver this water to the community by gravity does offer significant conveyance cost advantages over Buckman water, however.

2.3.1.1 Watershed Management and Reservoir Operation

This watershed consists of 17,200 acres of drainage area and is located within the public lands of the Santa Fe National Forest, part of which is designated as the Pecos Wilderness. The watershed is closed to the public pursuant to a 1932 order from the Secretary of Agriculture and through an updated Special Prohibition by the Forest Supervisor in 1991.

The United States Forest Service (USFS) has jurisdictional authority for the public land in the watershed. The USFS has issued a Special Use Permit for the use and operation of the dams and reservoirs in the watershed. The New Mexico OSE has jurisdictional authority over water diversion, water storage, water rights administration, and dam safety in the State of New Mexico. The OSE conducts dam safety inspections and has the legal authority to order dam safety improvements or draining of the reservoirs. The U.S. Army Corps of Engineers (COE) has federal authority for dam safety and has been involved in dam safety programs involving modifications to McClure and Nichols Dams.

Water from Nichols Reservoir is released into the Santa Fe River or diverted through the reservoir's dam tower into the Canyon Road WTP. Releases are controlled in response to demands from the WTP and downstream users (e.g., acequias). Under normal circumstances, water is supplied to the WTP on a continuous basis. Deliveries may be superseded during drought or other emergency conditions such as unforeseen events affecting the water quality in the reservoirs, water rights limitations, or the plant being taken out of service for maintenance or repair. Releases can be routed to bypass the WTP when circumstances warrant. In all cases, downstream acequia demands must be supplied pursuant to the agreements between SDCW and the acequia user groups.

2.3.1.2 Description of Dams

McClure Dam and Nichols Dam impound surface water collected from the Santa Fe Canyon watershed. McClure Reservoir is located at an elevation of approximately 7,900 feet above mean sea level (amsl) and has a storage capacity of 3,257 AF. The elevation of Nichols Reservoir is approximately 7,500 feet amsl. It has a storage capacity of 685 AF. The combined storage in both reservoirs is not permitted to exceed a total of 4,000 AF at any time (500 AF from Declaration 01278 plus 3,500 AF from License 1677).

SDCW maintains and operates McClure and Nichols dams. Historically, there were two other dams that are no longer in existence: Stone Dam (25 AF capacity), which was inundated by Two Mile Reservoir, and Two Mile Dam (500 AF capacity), which was deemed unsafe and subsequently breached in 1994.

McClure Dam. McClure Dam (formerly named the Granite Point Dam) was originally constructed in 1926. It was raised in 1935 and again in 1947. Additional improvements in 1995 brought the total current capacity to 3,257 AF. The dam is an earth and rock fill dam, which extends approximately 109 feet above the streambed, and is 695 feet long with a crest width of about 15 feet. The dam is classified as a large-size structure in the high-hazard potential category in the National Dam Inventory. The total drainage area to McClure is about 17.4 square miles (mi^2).

Nichols Dam. Nichols Dam was completed in 1943. The dam is an earth fill dam which is 80 feet high and approximately 615 feet long with a crest width of 30 feet. The dam capacity is approximately 685 AF. The dam is classified as an intermediate-size structure in the high-hazard potential category in the National Dam Inventory. The drainage area to Nichols is approximately 22.8 mi^2.

2.3.1.3 Monitoring and Releases

Stream flow in the Santa Fe River is monitored in five locations: inflow to McClure, flow between McClure and Nichols reservoirs; outflow from Nichols; near St. Francis Drive; and near Frenchy's Field. Precipitation is monitored at the McClure Reservoir and three other sites in town and the snowpack is monitored at two SNOTEL stations in the watershed.

The flow into McClure Reservoir is measured at a gaging station located at the reservoir inlet. Water is diverted through either an 8-foot or an 18-inch flume. Controlled releases from McClure are made through the outlet works intake tower control valves. Water flows are regulated by opening or closing these control valve(s). The valves are operated manually and require the dam operator to access the control tower via boat or over the ice. Water released from McClure enters the Santa Fe River channel and flows into Nichols Reservoir. Upgrades to the outlet works to allow for remote operations are planned.

Controlled water releases from Nichols Reservoir are made through intake valve(s) in the outlet works in the same manner as described above for McClure Reservoir. One intake valve is automated and can be controlled from the WTP. Water from Nichols Reservoir supplies raw surface water to the treatment plant. The WTP influent water pipeline inlet is located at the end of the Nichols outlet conduit. Controlled water releases to either the WTP and/or the Santa Fe River are made from the Nichols Reservoir outlet works. For water quality purposes, different strata of the reservoir are released through different levels.

Uncontrolled releases from both McClure and Nichols will be made when either reservoir reaches maximum storage capacity and excess water runs over the dam spillway into the Santa Fe River channel.

2.3.2 Factors Affecting Supply

The Santa Fe River supply is limited by a number of factors, including the following:

- Climate and meteorological factors
- Changes in watershed characteristics
- Water quality and treatment considerations
- Competing water rights, water management, and adjudications

Surface waters such as the Santa Fe River are highly dependent on precipitation. Flows in the Santa Fe River can be correlated to precipitation, as discussed in Section 2.3.3. While the reservoirs on the Santa Fe River help to equalize the variability of flows in the river, the amount of runoff in the watershed is directly affected by precipitation patterns. Other meteorological factors, such as the rate of evaporation, also affect the availability of water from this source.

Characteristics of the watershed can also affect the availability of water from this source. For example, an increase in tree density has been observed as a result of decades of fire suppression in the upper Santa Fe River watershed. As might be expected, data from the watershed suggests that as tree density has increased, the amount of runoff relative to a given amount of precipitation has decreased. This is discussed further in Section 2.3.3.

Water quality and treatment requirements can also affect the viability of a surface water supply. Degradation in water quality can either render a source unusable, or require more intensive treatment to meet potable water quality regulations. Santa Fe is fortunate to have a high-quality source of raw water in the Santa Fe River, which is treated at its Canyon Road WTP prior to distribution in the potable water system.

Water rights were discussed in Section 2.2. While water rights can limit the availability of water to a user, in the case of the Santa Fe River, yield from the river is often less than the City's rights.

2.3.3 Historical Precipitation, Stream Flows, and Storage/ Yield

To characterize the capacities and limitations of Santa Fe's water supplies, an understanding of the area's precipitation and hydrology characteristics is required. Precipitation, because it affects stream flow, is of particular relevance for surface water supplies, such as the City's Santa Fe River Canyon source. Finally, the analysis of this water resource must consider the effects of the Nichols and McClure Reservoirs on the upper Santa Fe River, used for storage of the Santa Fe River Canyon supply.

2.3.3.1 Precipitation

There are three main precipitation gages in Santa Fe, as shown in Table 2-3. The approximate geographic location of each is shown in Figure 2-6; the location of each gage has varied slightly over time. Yearly precipitation totals for the full periods of record for each station are shown in Figure 2-7. Yearly precipitation values vary greatly, with no apparent long-term trend. Monthly average precipitation totals over the periods of record are plotted on Figure 2-8 for Stations 8072 and 8085. Station 8078 is not included due to its relatively short period of record. July and August are typically the 2 months with the highest precipitation, while December through February typically represent the driest months.

Table 2-3 Summary of Precipitation Gages

Station	Period of Record	Avg. Annual Precipitation (in)	Max. Annual Precipitation (in) - Year	Min. Annual Precipitation (in) - Year
8072	1868 - 1972	13.79	21.75 - 1881	2.76 - 1883
8085	1973 - 1998	14.33	20.09 - 1994	7.89 - 1976
8078	1948 - 1957	9.24	14.99 - 1949	3.12 - 1956

The variability in precipitation affects the degree to which the surface water source can be relied upon. The cyclical nature of precipitation patterns (e.g., droughts) can be demonstrated by plotting the deviation from annual average precipitation. The cumulative departures from the overall mean annual precipitation for the respective periods of record are plotted for the two main precipitation stations (i.e., those with long-term data) on Figure 2-9. Annual precipitation totals over the past 16 years (1983-1998) have generally been higher than the long-term average (an upward trend in the cumulative departure). Figure 2-9 also shows the significant drought experienced in the region between the 1940s and early 1950s. It was this extended dry period that prompted many New Mexico communities, including Santa Fe, to construct groundwater wells in the 1950s. The drought is also reflected in the average precipitation value for gage 8078, which was maintained only from 1948 to 1957.

2.3.3.2 Streamflow

To provide insight into the availability and dependability of the City's Santa Fe River water supply, an analysis of flows on the upper Santa Fe River was conducted. One USGS flow gage on the upper Santa Fe River contains significant historical data. This gage, 08316000, is located between McClure and Nichols Reservoirs. Details of the gage and relevant flows (water year basis) are presented in Figure 2-10. Additional gages have recently been installed just above McClure Reservoir and just below Nichols Reservoir, but neither has significant historical data associated with it.

The mean and median daily streamflows for each water year in the period of record at gage 08316000 are plotted on Figure 2-11. The values shown are the mean and median of the daily averaged flows for each water year, converted to units of AFY. The overall mean (6,051 AFY) and median (4,873 AFY) values for the full period of record (water years) are also shown on this figure. Median monthly flows for this gage are plotted in Figure 2-12.

On the upper Santa Fe River, the highest flows typically occur in May, while the lowest flows occur in December and January. Flows at this gage (8316000) are tempered by the presence of McClure Reservoir just upstream of the gage. Figure 2-13 shows the cumulative departure from the overall daily mean for this gage. This figure shows that flows over approximately the past 20 years have been generally higher than the long-term average, which followed an extended period of low flows from about the 1940s through the 1970s.

To determine flow rates on the Santa Fe River above McClure Reservoir (i.e., uncontrolled watershed runoff rates), McClure inflow values were estimated by back-calculating the flow based on the change in reservoir storage and the approximate McClure outflows (gage 08316000). In other words, the average daily inflow was set equal to the change in storage for that day plus the average daily outflow. (USGS maintains electronic data of daily reservoir levels from 1965 to the present. Prior to 1965, only hard copy end of month level data are available.)

Seasonal peak flow rates were identified in the upper watershed from this analysis, coinciding with summer rains. However, dry season flow rates typically stayed below 5 cfs for extended periods. Flows this low would likely be fully infiltrated into groundwater, resulting in little or no flow in the river in town, even without the presence of the reservoirs.

Thirty-day moving average daily flows were calculated for gage 08316000 for the past 30 years (1968-1997). The 30-day average daily low flow for this period was estimated to be 0.183 cfs. This low flow period occurred from November 14, 1996 to December 13, 1996. The 30-day average daily flows for the Santa Fe River upstream of McClure Reservoir were estimated for the past 30 years. The 30-day average daily low flow for this location was estimated to be 0.85 cfs and occurred from January 14, 1981 to February 12, 1981.

2.3.3.3 Reservoir Storage

Measured storage values for McClure and Nichols Reservoirs over time are provided in Figures 2-14 and 2-15, respectively. Large fluctuations in reservoir storage can be seen for both reservoirs, with McClure ranging from approximately 300 AF to 3,300 AF, and Nichols ranging from approximately 90 AF to 710 AF. Reservoir storage levels vary in response to seasonal and annual runoff fluctuations and potable water demands.

2.3.3.4 Relationships of Precipitation, Santa Fe River Flow, and Reservoir Storage

The impacts of precipitation on Santa Fe stream flow and stream flow on storage levels in the McClure and Nichols Reservoirs are evident from some of the available data. Figure 2-16 shows monthly precipitation overlaid on monthly Santa Fe River flow (at gage 08316000) for two different local precipitation gages and three different decades. In general, local peak stream flows correspond to peaks in the average precipitation. Peak flows at this gage can be expected to be dampened somewhat by the presence of McClure Reservoir immediately upstream in the years after its construction (1943). However, the data appear to indicate a trend towards lower runoff for a given precipitation amount in recent years. This may be due to changes in the tree density in the watershed.

Figures 2-17, 2-18, and 2-19 show the cumulative departure from the overall mean monthly flow for gage 08316000 and from the overall mean monthly precipitation for different historical periods. A direct relationship between these parameters is apparent, as the general trends match each other closely.

Relationships between reservoir levels and stream flow are less-easily determined because the releases from both reservoirs are regulated (with the exception of infrequent reservoir spill events). As expected, however, during the extended low flow period in 1981 above McClure Reservoir (January 14, 1981 to February 12, 1981), storage levels in both McClure and Nichols were significantly lower than average (approximately 900 AF and 270 AF, respectively).

2.3.4 Quantification of Limitations in Supply

A simple reservoir routing model was created in order to develop a reasonable planning estimate of water availability in McClure and Nichols reservoirs during low-flow periods in the Santa Fe River. This dynamic model predicts reservoir storage, water levels, and spills over time in both McClure and Nichols, based on upstream flow inputs, controlled release inputs, evaporative/precipitation conditions, and initial storage values. The model is written in *Visual Basic* for *Excel* spreadsheets and provides an easy way to investigate long or short-term trends in reservoir storage and water availability. The model could also be used as a management tool for planning reservoir releases based on storage requirements and water supply demands. A description of the model is provided in Appendix B.

A predictive simulation was performed using this model to determine an appropriate low surface water yield for planning purposes. This scenario represents a very likely minimum supply, not an absolute worst case scenario. A 180-day low-flow scenario was simulated based on data from the drought in the 1950s. The goal of this analysis was to determine the maximum allowable average daily withdrawal schedule from both reservoirs that maintains at least 20 percent of maximum capacity in the two reservoirs at the end of the low-flow period. This minimum level (651 AF for McClure; 137 AF for Nichols) was selected as a conservative level for minimum reserve storage.

The lowest 180-day flow series at gage 08316000 (between McClure and Nichols reservoirs) from the 1950s was determined to be from September 1956 through March 1957, late in this drought cycle, when storage levels and flows might be expected to be low. This flow series was used as the inflow series to McClure for this simulation, recognizing that in times of drought, flows are not stored in the upper reservoir, and influent flow to McClure should be approximately equal to outflows (releases).

A net evaporation/precipitation rate of 0.0 was assumed for the entire 180-day period, meaning that direct precipitation on the reservoirs approximately equals evaporative losses. While evaporation data are not available for these reservoirs, data from Nambe Falls Reservoir in northern New Mexico indicate a net evaporation rate of about 1.2 inches during these months. Over the 180-day period, at the reservoir levels modeled, net evaporation losses equate to about 0.01 mgd (0.03 AF/day). This is considered negligible relative to the overall use of this supply source. Starting storage values for McClure and Nichols were set equal to the average measured volume (1,877 AF for McClure; 437 AF for Nichols) for most recent 35-year period (1965 - 1999).

To determine the inflow to Nichols (from which withdrawals are taken), McClure Reservoir must first be evaluated. McClure average daily releases were varied first in the model until the target storage value (20 percent of capacity) was achieved. A maximum daily average release of 4.1 cfs (2.7 mgd, or 2,980 AFY on an annualized basis) was determined to be available from McClure reservoir for the full 180-day period. McClure releases were used as the inflow to Nichols. Given this daily release from McClure, releases from Nichols were varied until the 137 AF target storage was achieved. A maximum daily average release of 4.9 cfs (3.2 mgd, or 3,550 AFY on an annualized basis) was determined to be available from Nichols for use in potable supply for Santa Fe, resulting in Nichols storage of 20 percent of its capacity at the end of the simulation. Thus, 3.2 mgd is the total flow available under these conditions for downstream water use (including the WTP and the acequias).

The model demonstrates that under these planning conditions, the reservoir yields are not sustainable. That is, stored water is being used at a higher rate than it is being replaced. Upon reaching the 180-day endpoint in this modeled situation, withdrawal rates would need to be reduced drastically unless an immediate increase in precipitation was observed.

A second scenario was modeled, using the same conditions but with a starting level in each reservoir equal to 20 percent of the reservoirs' capacities. Because the starting level was 20 percent, levels were allowed to drop below 20 percent, as long as the final level at the end of the simulation reached 20 percent. Under these conditions a maximum withdrawal rate of 0.7 cfs (0.45 mgd, or 510 AFY) is permissible from Nichols. This demonstrates the effect storage levels at the beginning of a drought have on allowable withdrawal rates. However for planning purposes, the 3.2 mgd value developed in the first scenario will be used because it is a more reasonable scenario for planning purposes, recognizing that in any given year, it is theoretically possible that no surface water would be available.

The Canyon Road WTP was designed to treat an average flow of up to 8 mgd, with a maximum rated capacity of 9.72 mgd. Clearly, even when treatment peaking factors are considered, watershed yields in the Santa Fe River Canyon are often the limiting factor in the minimum "dependable supply" from Santa Fe River surface water. Operational needs can also dictate the use of this plant. For example, the plant flow rate may be reduced to increase reservoir storage, in preparation to meet anticipated seasonal peak demands. The plant is generally operated at a flow rate that is a multiple of 2 mgd, to maintain relatively constant filter loadings (by turning filters on or off).

2.4 City Well Supply

2.4.1 Production Facilities

The City Well Field is mostly located in close proximity to the Santa Fe River. It includes seven wells that are connected to the distribution system that are actively used. Water pumped from these wells is introduced to the distribution system immediately after onsite treatment. Two additional wells are being developed; these will also be connected directly to the City's distribution system. The City has different pressure zones, with different wells in several zones.

A map of the City Wells was provided in Figure 2-3. Additional data on the wells is included in Appendix C.

2.4.2 Factors Affecting Supply

Water Rights. Water rights limit the amount of water that may be used by the City in a year. Rights to the water only provide the authority to use the water; they do not guarantee the availability of water.

As described in Section 2.2, the City Well water rights restrict the total pumping to 4,865 AFY (excluding St. Michael's Well). Over the 10-year period from 1990 to 1999, the City withdrew an average of about 2,050 AFY. The City's pumping was limited by other factors as described below. During this period, annual use ranged from 1,024 AFY (1997) to 2,598 AFY (1990). The maximum ever withdrawn from this well field was 3,630 AF in 1970 (excluding St. Michael's Well), which occurred prior to the development of the Buckman Well Field.

Well Capacity. The present capacities in the City Well Field (excluding St. Michael's Well) are shown in Table 2-4.

The planned wells (Hickox and Northwest) will add an estimated 1,500 AFY or more of capacity to the City Well system. With these wells on line, the City will have the infrastructure in place to pump at or near the full City Well right amount of 4,865 AFY.

Table 2-4 Status of City Wells

Well Name	Status	Pumping Capacity (gpm/mgd)	Active Wells Annual Capacity (AFY)
Agua Fria	Active	885/1.27	1,428
Alto	Active	250/0.36	403
New Country Club Estates	Planned [1]	290/0.41 [1]	–
Ferguson	Active	250/0.36	403
Osage	Active	270/0.39 [2]	25.06
Santa Fe	Active	225/0.32	363
Torreon	Active	450/0.65	726
Hickox	Planned [1]	150/0.22	–
Northwest	Planned [1]	900/1.30	1,452
Total (Active, not including St. Michael's)		5.66 [3]	4,799.7

[1] Pending water rights application. The New Country Club Estates well will not be able to be pumped at the maximum capacity for extended periods of time.

[2] Can only be pumped for 10 days per year at this rate. Annual capacity value assumes pumping at half of max. capacity for remainder of year.

[3] Total instantaneous capacity cannot be converted to annual capacity due to water rights and other constraints.

The St. Michael's well is active and has an estimated pumping capacity of 475 gpm (0.67 mgd). The joint water right for St. Michael's well and the surface water supply limits St. Michael's pumping to 1,000 gpm and a total of 700 AFY. Using the existing infrastructure, the well could be pumped at its full pumping capacity (475 gpm) for approximately 11 months each year to meet the 700 AFY limit.

Aquifer Constraints and Sustainable Yield. For sustainable pumping of groundwater, the rate of groundwater withdrawals must equal the rate of recharge on an average basis. The proliferation of domestic wells in the area, combined with the City Wells, constitutes a significant demand on the aquifer. This aquifer sees limited natural recharge due to the precipitation and hydrologic characteristics of the region. At present, no intentional "artificial" recharge occurs in the aquifer. This results in a situation in which the aquifer is being pumped at a rate higher than it is being recharged locally. Drawdown of the water table from nearby wells in the aquifer also affects the yield that can be drawn from a well at a given well depth, as do local hydrogeologic characteristics (e.g., aquifer transmissivity) and water quality (e.g., Santa Fe Well).

A recent evaluation of the sustainability of City Well Field pumping (Shomaker 1998) concluded that without additional recharge, up to 3,725 AFY (including St. Michael's) could be pumped from this source on average. This amount of pumping assumes that the pumping stress will be spread to more wells in the future. It also allows for a 2-year drought. Land subsidence and other effects were predicted at higher pumping rates. Given this evaluation, hydrologic characteristics are more restrictive than water rights for this source.

Available USGS water table elevation data for a cluster of monitoring wells located near the St. Michael's well are plotted in Figure 2-20. The location of these wells (named SF-1a, SF-1b, and SF-1c) are shown on the map in Figure 2-3. The data indicate minor reductions in the water table elevation in this area between 1986 and 1999 of about 6 feet and 9 feet for wells SF-1a and SF-1b, respectively, and widely variable elevations at well SF-1c.

A detailed analysis of water levels was undertaken for wells SF-1B and SF-1C. Water level measurements were collected on a consistent basis from these wells from February 1998 through December 1999 and are plotted on Figure 2-21. To provide greater detail on water level trends, the water levels shown on Figure 2-21 are relative to the measurements recorded at the start of the period. Water levels in well SF-1C show monthly fluctuations of up to 50 feet while monthly fluctuations in well SF-1B are on the order of 1 to 3 feet. The SF-1 observation well cluster is located near the St. Michael's well so monthly pumping records for this well are also shown on the figure. Changes in water levels in well SF-1C are opposite the patterns of pumping from the St. Michael's well. Conversely, water level trends in well SF-1B show little correlation to St. Michael's well production and instead tend to follow an annual pattern of lowest levels in late summer and highest levels in late winter.

A comparison of well screen elevations can explain the water level patterns seen in the SF-1 observation wells. The St. Michael's well is screened at elevations of 6,074 to 6,474 feet. Well SF-1C is screened at elevations of 6,006 to 6,011 feet, approximately 65 feet below the St. Michael's well. Well SF-1B is screened at elevations of 5,650 to 5,655 feet, over 400 feet below the St. Michael's well. Well SF-1A is screened even deeper, at more that 1,300 feet below the St. Michael's well. The general trends in water levels in the SF-1 observation wells are directly related to the proximity of their well screens to the well screen interval of the St. Michael's well. Well SF-1C shows almost immediate and significant changes in water levels corresponding to production from the St. Michael's well, suggesting that the two wells are screened in a portion of the aquifer system that is hydraulically connected. In contrast, water levels in wells SF-1B and SF-1A show more seasonal trends, likely related to regionwide pumping. The deeper wells at the SF-1 location do not appear to be in direct hydraulic communication with the aquifer zone from which the St. Michael's well withdraws water.

Water Quality. Water quality is a major concern because it has the potential of becoming a constraint for assuring water deliveries. In the City Well Field, there are many potential sources of contamination. Contamination has been detected at several well sites. Among the detected contaminants in the aquifer that are associated with human activity are organic solvents. In response to the contamination, one well (Torreon) has been redrilled and remediation facilities have been constructed at two other sites (Alto and Santa Fe wells). If the contamination levels and affected areas increase, then the City Well Field production may be seriously curtailed. This highlights the need for a wellhead protection program.

2.4.3 Quantification of Limits in Supply

Based on the above considerations, the City Well Field will be limited by water rights after the planned well improvements are complete. However, if the wells are to be operated sustainably, the average withdrawal allowed is 3,725 AFY (including St. Michael's, which is limited to a maximum of 700 AFY). Because of the potential negative effects of nonsustainable operation, this will be considered to be the maximum allowable withdrawal rate, except in drought years. When surface supplies are low, the City anticipates using the full 4,865 AFY.

2.5 Buckman/ San Juan-Chama Supply

2.5.1 Production Facilities

The Buckman system includes a well field located adjacent to the Rio Grande, booster stations and a transmission line. The well field consists of eight deep set wells, with product water repumped by four pump stations through a pipeline conveying it about 15 miles into town. The total static lift from the water table elevation in the well field to terminal storage is over 2,000 feet. Storage facilities are used to buffer supply against demand in the pipeline between the well field and town. There are also several observation wells in the Buckman area.

Estimated individual and total Buckman well capacities are shown in Table 2-5. The Buckman *pipeline* has a capacity of about 8.8 mgd. This is greater than the total pumping capacity of the wells, which would be about 7,130 AFY (6.36 mgd) if all wells were pumped continuously. Recent diversions from the Buckman source have been lower (averaging about 4,900 AFY from 1990-1999) due to operational issues and fluctuations in demand. 1995 saw the highest withdrawals from Buckman on record, with a total diversion of nearly 5,900 AF that year.

Table 2-5 Capacity of Buckman Wells

Well Name	Approx. Capacity (gpm/mgd)
Buckman 1	620/0.89
Buckman 2	750/1.08
Buckman 3	350/0.50
Buckman 4	375/0.54
Buckman 5	350/0.5
Buckman 6	620/0.89
Buckman 7	760/1.09
Buckman 8	595/0.86
Total	**4,420/6.36**

Buckman Well 5 has lower water quality and when used in the past was normally blended with production from other wells. This well was typically used only to meet high production requirements.

2.5.2 Storage Facilities for Santa Fe's SJC Water

The SJC project, authorized in 1962 comprises a portion of the Colorado River Storage Project. SJC water is now allocated to a number of entities, including the City of Santa

Fe and Santa Fe County, each holding a contract with the U.S. Bureau of Reclamation. SJC water is diverted via a series of tunnels to bring tributary water of the San Juan River from Colorado to Heron Reservoir in northern New Mexico.

Heron Reservoir stores SJC water for all its users. Typically, contract holders not placing a call on their contract water from Heron by December 31 lose access to that water, although exceptions have been made for fishery flow enhancements and other special conditions and ISC allows a grace period until the end of April of the following year. Following SJC water downstream from Heron Reservoir, it is conveyed down the Rio Grande and stored in El Vado Reservoir and Abiquiu Reservoir before reaching the Santa Fe area (i.e., near the Buckman Well Field).

El Vado Reservoir is owned by the Middle Rio Grande Conservancy District (MRGCD), who stores its SJC water and leases storage space to other SJC users and native Rio Grande water rights holders. El Vado was built in 1935. Abiquiu Reservoir is owned and operated by the COE. Its primary intent is flood and sediment control, but the COE has authorized its use for storage of SJC water. The City of Albuquerque has an easement for most of this storage capacity, but a small amount (11,000 AF) is leased by the City of Santa Fe and other SJC contract holders.

2.5.3 Factors Affecting Supply

A number of factors affect the availability of the Buckman source of supply. Among these are:

- Hydrogeology of local aquifer and connection to Rio Grande
- Offset requirements
- Capacity of wells and pipeline
- Water quality considerations
- Sustainability

As discussed in Section 2.2.3, withdrawals from the Buckman Well Field are limited by the permit for withdrawal (10,000 AFY) and the requirement to hold offsetting water rights. This is related to the hydraulic connection and hydrogeology of the system connecting the Rio Grande and tributaries to the groundwater in the vicinity of the Buckman wells. The State Engineer's estimates this connectivity and the effects of pumping using modeling techniques to determine the annual offset requirements.

Under current offset ratios (around 0.45) and water rights holdings, requirements for offsetting water rights on the Rio Grande do not restrict the City from pumping the full permitted quantity of 10,000 AFY. However, the City's rights on the tributaries would be inadequate at that production rate and must be supplemented by use of Las Campanas rights on tributaries. This source is also limited to 7,130 AFY (annual average of 6.36 mgd) by infrastructure as discussed above. With increased pumping capacity, higher diversions may be possible, until such time as offsetting water rights limit the use of this source. Any *instantaneous* flows higher than 8.8 mgd would require improvements to the conveyance infrastructure.

As with virtually any well field, the Buckman Well Field has a finite capacity for sustainable withdrawals. The sustainable yield from this aquifer is a function of the rate of natural recharge to the aquifer, as well as hydrogeologic conditions. Computer modeling of this well field has been performed to estimate the sustainable yield of the aquifer. The sustainable yield was determined to be approximately 5,000 AFY on average (Boyle 1997). Available USGS data from the SF-2 monitoring wells (location shown on the map in Figure 2-4) plotted in Figure 2-22 indicate that water table elevations have dropped significantly in recent years. Between 1986 and 1999, the data suggest reductions in elevation of about 150 feet at both SF-2a and SF-2c. During the same time, water table elevations at SF-2b have shown significant variability, but a drop of around 300 feet is apparent.

Unsustainable pumping practices could be continued for a period of time. However, over time, water table levels would drop further, yields from the well field would be reduced, and the costs of production would increase dramatically. Eventually, this source of supply may become virtually unusable unless pumping is restricted to sustainable pumping rates. With the City's initiative toward more sustainable water use practices, it is reasonable to plan for maintaining the long-term withdrawals at or below the 5,000 AFY sustainable limit.

2.5.4 Quantification of Limits in Supply

The City is dedicated to moving towards more sustainable water use practices at all levels. Although the permit allows diversion of up to 10,000 AFY, and current offsetting water rights and offset ratios might allow this level of pumping with new infrastructure, 10,000 AFY has been determined to not be sustainable over the long term, without additional diversion points other than the Buckman Well Field. Therefore, the yield of the Buckman Well Field for future planning is considered to be 5,000 AFY on average, equal to the sustainable yield.

2.6 San Juan-Chama Diversion Pilot

As described in Section 2.2, the City holds significant contract rights for the SJC project water. Presently, the City uses only a portion of this water, primarily for offsetting Buckman withdrawals. To more efficiently utilize this existing water supply, the City and PNM studied alternatives for diverting SJC water more directly for potable use. Alternatives investigated included direct diversions from the Rio Grande and infiltration gallery technologies (Boyle 1997). The technology selected for diverting SJC water was horizontal collector wells, in which subsurface perforated pipes radiate from a central collection casing. The infiltration gallery piping is typically placed adjacent to or underneath a river. Water is drawn by gravity from the river through the streambed and into the collection pipes, which convey the water to the central casing. The water produced is then pumped from the casing to treatment and/or distribution facilities.

To gain a more thorough understanding of the feasibility and possible design values for using this technology to divert SJC water from the Rio Grande, the City has initiated a pilot-scale investigation. In a unique partnership with Santa Fe County and the Pueblo of San Ildefonso, the City is constructing one horizontal collection well as a pilot unit immediately adjacent to the Rio Grande on San Ildefonso Pueblo land. This agreement is reflective of a shift towards regional water planning, supported by the City and with multiple potential benefits to the region. The site of the pilot diversion, shown on the map provided as Figure 2-1, was identified in previous studies as being a strong candidate site for efficient rates of diversion using horizontal collection wells. At the conclusion of the planned piloting period (about 1 year, ending in 2001), the three parties will assess the data to determine the feasibility of using this technology at this site. Also, the quality of the water produced from the pilot well will be evaluated to determine the degree of potable treatment that will be required for this water. San Ildefonso Pueblo will then consider their benefits against potential impacts to their lands. If approved, this would allow a full-scale project to move forward. A long-term agreement must be negotiated at that time.

If the rates of water production and water quality produced indicate that the use of horizontal collector wells are a feasible and cost-effective means of diverting SJC water, the City may construct additional collector wells with its regional partners. These collector wells could be used to divert the City's full SJC contract allotment, plus any native Rio Grande rights held or acquired by the City or its partners and/or additional SJC water from the partners, and possibly the return flow credits. If the horizontal collector well pilot program does not indicate feasibility, alternative approaches to diverting SJC water from the Rio Grande will be considered.

2.7 Treated Wastewater Effluent Supply

City of Santa Fe treated effluent has been utilized for irrigation since 1941 by a variety of users. As our water use increases, the amount of treated effluent available for use also increases. The City is looking at ways of utilizing the treated effluent where potable water quality is not essential.

The City of Santa Fe operates a single WWTP, located in the southwest part of the City. The location of the City's WWTP is noted on the map in Figure 2-1. Recognizing treated effluent as one of the City's existing and available water resources, and the sustainability characteristics inherent to effluent use, the City conducted a thorough evaluation of alternatives for expanding its treated effluent use program (CDM 1998). The future availability of treated effluent depends on:

- WWTP flow projections
- Historical downstream water uses and senior water rights on the lower Santa Fe River
- Maintenance of baseline stream flows in the lower Santa Fe River, including estimates of seepage rates and other losses
- Existing contracts and agreements to provide treated effluent for nonpotable use

It is anticipated that flow discharged to the Santa Fe River at the WWTP will be used to maintain baseline flows in the river and to help provide water for historical downstream uses. The total daily maximum flow required by the existing users' (Santa Fe Country Club, Soccer/Polo Grounds, Santa Fe Downs, and the Municipal Recreation Complex) current contracts/ agreements is approximately 4.6 mgd, or 5,200 AFY. However, actual annual use rates are significantly lower due to seasonal fluctuations in irrigation demand. Table 2-6 summarizes recent WWTP and reuse flows. Treated effluent for the existing reuse customers is pulled from the WWTP effluent channel and pumped to each site via a dedicated pipeline (one pump station and pipeline per customer).

As the amount of treated wastewater at the WWTP increases over time, the available supply of treated effluent also increases. Moreover, since the existing users are primarily irrigation-related, their needs peak in the summer, leaving much of the plant's effluent available for reuse at other times of the year. A wide range of potential reuse applications for the available effluent were analyzed in the development of the TEMP, resulting in one plan selected for implementation that is composed of several reuse applications.

Table 2-6 Recent WWTP and Reuse Flows [1]

Parameter	1995-1999 (mgd)	1995-1999 (AFY)	1999 (mgd)	1999 (AFY)
Total reuse demands, average	0.69	770	0.68	760
Total reuse demands, max day	4.18	4,680	4.18	4,680
Total plant flow (including reuse), average	6.24	6,990	6.01	6,730
Total plant flow (including reuse), max day	8.25	9,240	8.25	9,240

2.8 Summary of Existing Potable Water Supply Quantities

Santa Fe's sources of water supply are limited by a number of factors, as discussed in the preceding sections. A summary of the supply capacity of each source is provided in Table 2-7. In this table, the 1-in-4 year drought "planning" scenario is that in which the yield from the Santa Fe River is less than the full water right. This value is based on the outcome of the modeling work described in Section 2.3.4, in which a 180-day low-flow period in the river was analyzed for allowable withdrawals from the reservoirs. The "maximum" supply scenarios demonstrate the availability of water during a wet year, when the full water right is available in the Santa Fe River. Sustainable and nonsustainable scenarios are compared for a wet year in Table 2-7. It is important to recognize that water availability (and therefore the values in Table 2-7 for this situation) would ultimately drop off significantly as water resource supplies are exhausted. Figure 2-23 summarizes Santa Fe's current supply capacity.

Actual yields in the Santa Fe River are likely to be less than the planning values (dry conditions) in some years. During the period from 1980 to 1999, for which demands were high enough that the City may have been using all available surface water each year, surface water withdrawals have exceeded the 1-in-4 year drought planning value of 3,550 AFY in 16 of those 20 years. During years that are drier than this planning scenario, with existing infrastructure and water rights, the sustainable planning value of about 12,275 AFY will not be available unless one or more of the following measures are taken:

- Temporarily increased pumping from Buckman (provided that the appropriate quantity of offsetting water rights are available, as calculated annually by the State Engineer's Office)

- Temporarily increased pumping from the City Well Field, up to the full 4,865 AFY water right (or higher if a conjunctive surface water/groundwater right is granted), plus 700 AFY from St. Michael's Well.

Alternatively, enhanced demand management measures could be implemented to reduce demand during dry periods. These are discussed in Section 4.

The total sustainable local water supply capacity (Santa Fe River, St. Michael's Well, plus City Wells) presently ranges from about 6,400 AFY (1-in-10 year planning) to 8,800 AFY, depending on the amount of runoff in the Santa Fe River Canyon. Ideally, runoff in the watershed and the City's existing infrastructure would together provide the capacity to supply an amount of water equal to the City's local water rights holdings (9,905 AFY) each year.

For imported water, under present conditions (i.e., offset ratio), the City has more than sufficient offsetting water to allow pumping of the full permit amount of 10,000 AFY. However, infrastructure and yields from existing well field configurations limit the production capabilities to about 7,130 AFY. To operate the Buckman Wellfield sustainably requires that withdrawals be limited to 5,000 AFY on average.

Based on this analysis, a sustainable, planning level total existing capacity of 12,000 AFY will be used in subsequent analyses.

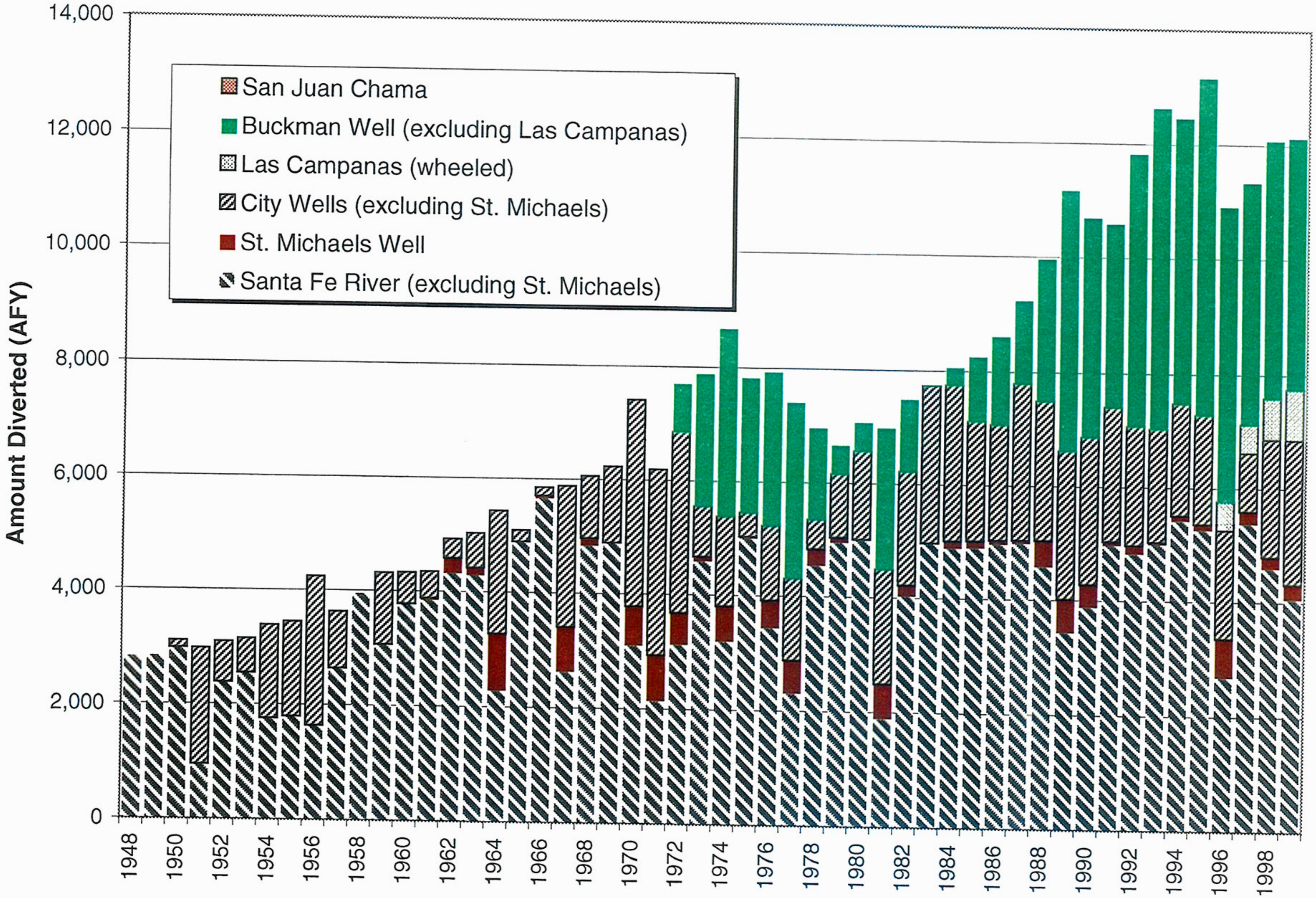
Table 2-7 Summary of Santa Fe Supply Capacities

Source	Sustainable or Nonsustainable Practices	Planning Scenario Approx. 1-in-10 Year Drought	Planning Scenario Approx. 1-in-4 Year Drought	Maximum Supply (Wet Year)	Limiting Factor for Each Supply Scenario
Santa Fe River	Sustainable	2,684 AFY	3,550 AFY	5,040 AFY	Water availability in watershed (dry); Water rights (wet)
	Nonsustainable	2,684 AFY	3,550 AFY	5,040 AFY	
St. Michael's Well [1]	Sustainable	480 AFY	480 AFY	0	Well infrastructure (dry); joint surface water rights with Santa Fe River of 5,040 AFY (wet)
	Nonsustainable	480 AFY	480 AFY	0	
City Wells [2]	Sustainable	3,245 AFY	3,245 AFY	3,725 AFY	Joint limit on well field sustainability with St. Michael's well (sustainable); water rights (nonsustainable)
	Nonsustainable	4,865 AFY	4,865 AFY	4,865 AFY	
Buckman Wellfield	Sustainable	5,000 AFY	5,000 AFY	5,000 AFY	Well field sustainability (sustainable); Buckman well infrastructure (nonsustainable)
	Nonsustainable	7,130 AFY	7,130 AFY	7,130 AFY	
Total with S.F. County and L.C.	Sustainable	**11,409 AFY**	**12,275 AFY**	**13,765 AFY**	
	Nonsustainable	**15,159 AFY**	**16,025 AFY**	**17,035 AFY**	
Total without S.F. County and L.C.	Sustainable	**10,034 AFY**	**10,900 AFY**	**12,390 AFY**	
	Nonsustainable	**13,784 AFY**	**14,650 AFY**	**15,660 AFY**	

L.C. - Las Campanas (1,000 AFY)
S.F. County - Santa Fe County (375 AFY)

1 Use of St. Michael's Well maximized in drier ("planning scenario") years. Dry year total water use for St. Michael's and Santa Fe River does not exceed the combined water right of 5,040 AFY. In wet (maximum) years, it is assumed that the entire combined water right will be withdrawn from the Santa Fe River.

2 Sustainability limit of 3,725 AFY applies to City Wells plus St. Michael's Well (Shomaker 1998). In "planning" scenarios, this is split between St. Michael's and City Wells. In "maximum sustainable" scenario, the entire sustainable limit is pulled from City Wells, since water rights limit the ability to use St. Michael's when all Santa Fe River rights are withdrawn from surface water. All currently planned City Well improvements are assumed complete, with pumping capacity in the well field equal to the water rights limit (4,865 AFY).



CDM Camp Dresser & McKee
SDCW Diversions Historical.xls: Fig 2-2 1/10/2001

Figure 2-2
Historical Diversions for Potable Supply, 1948-1999

Figure 2-3
Map of City Wells
Santa Fe, New Mexico

dend037 u:\projects\active\santafe\apr santafeworkingnew.apr city well layout 022100 scp

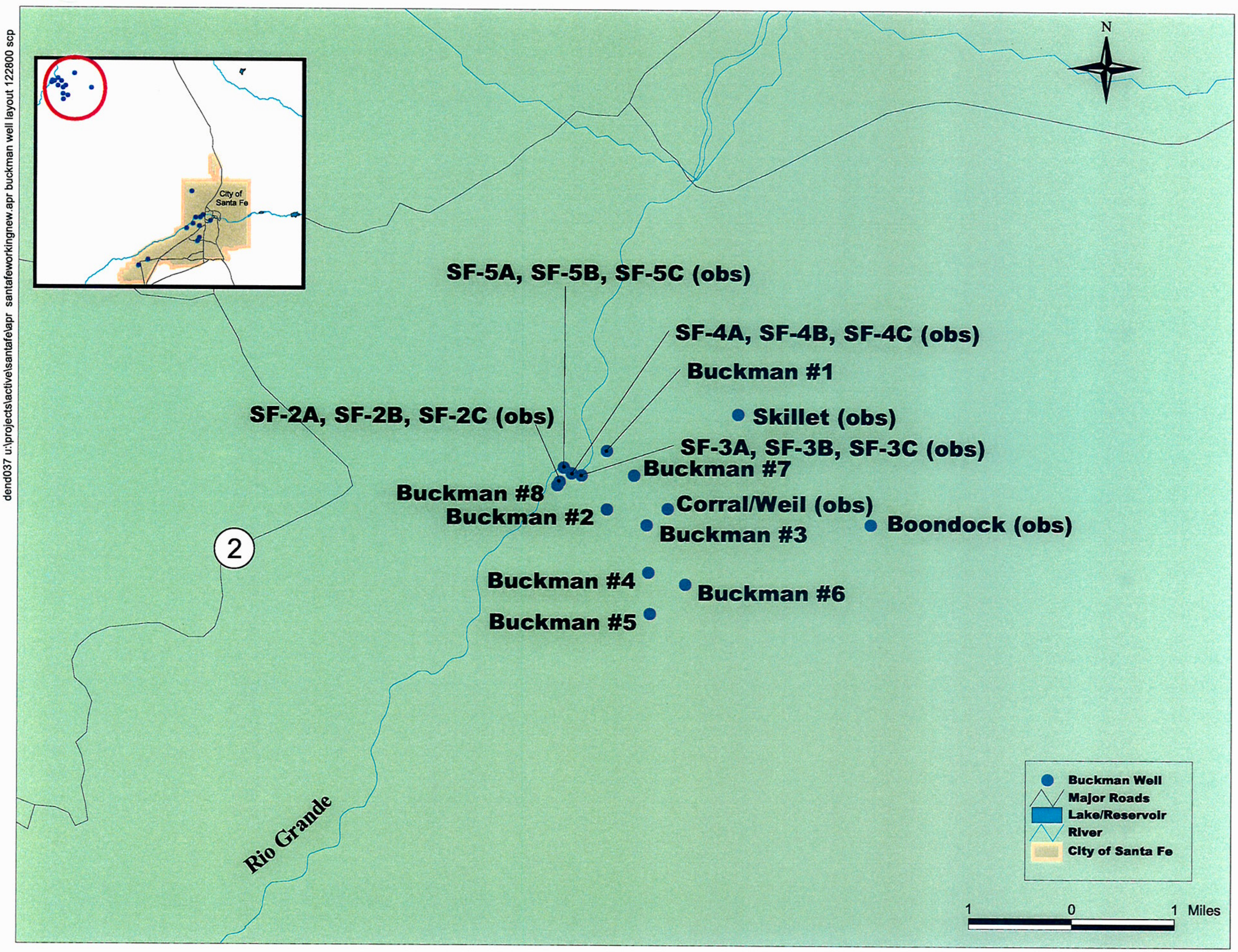
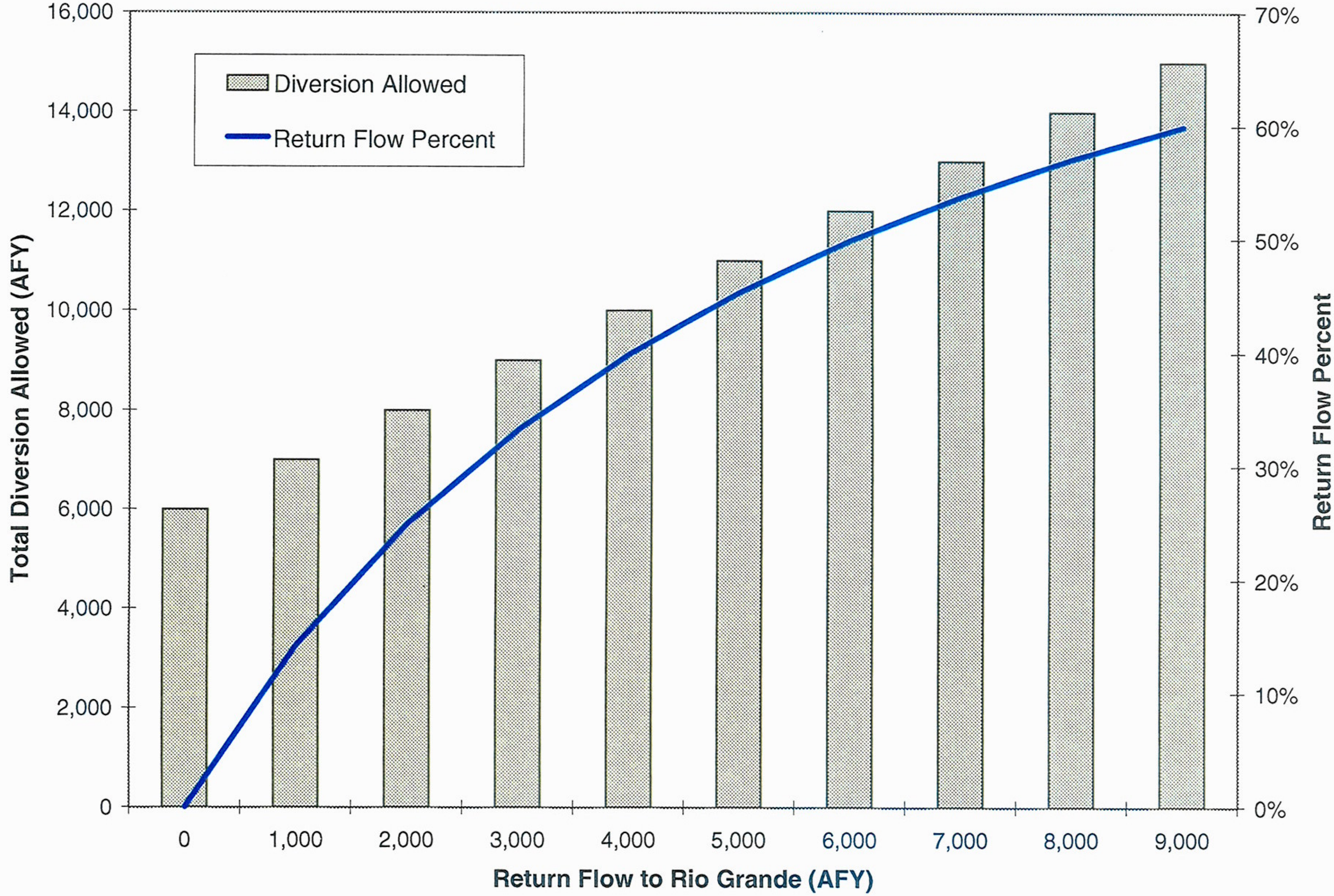


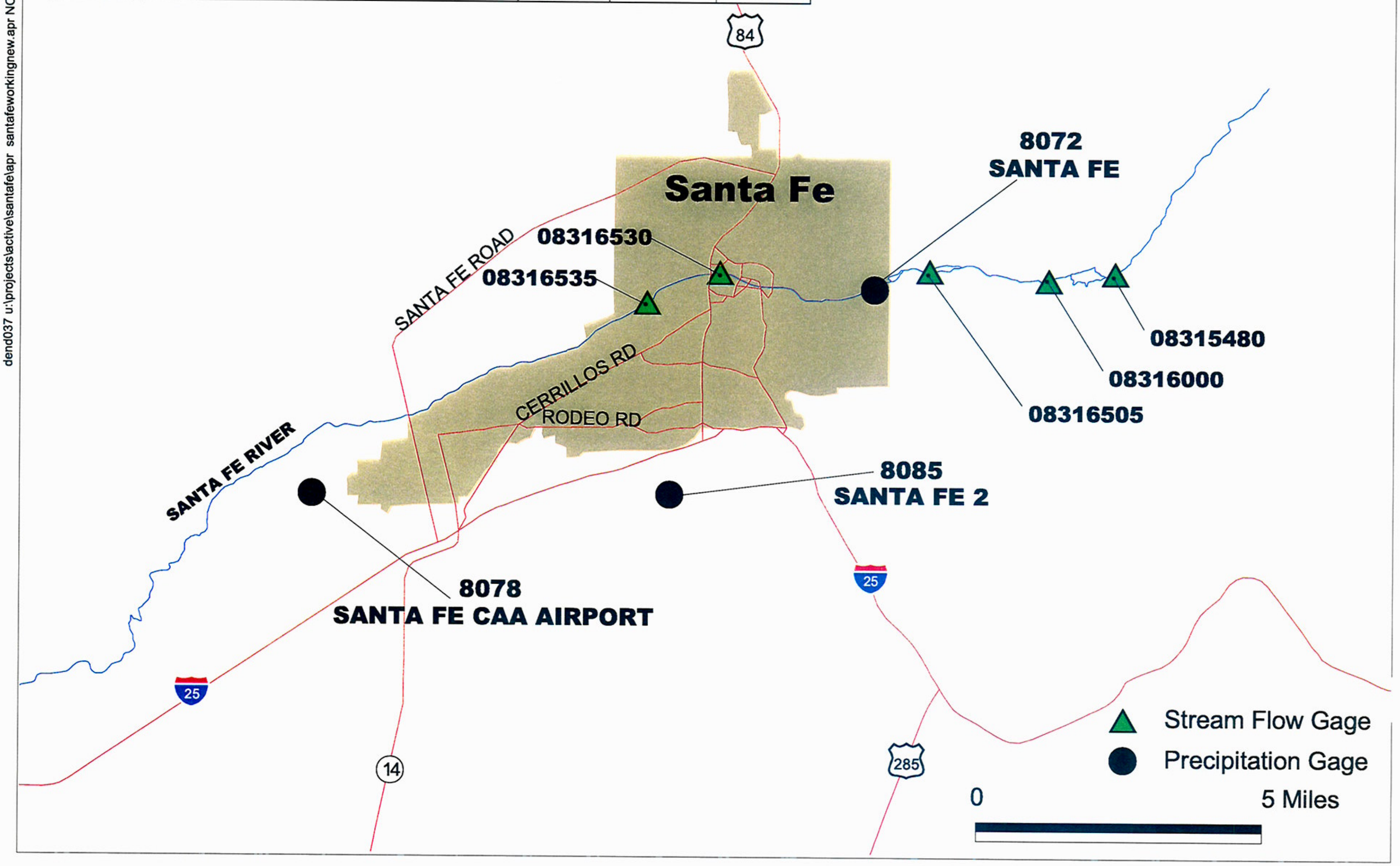
Figure 2-4
Map of Buckman Wells
Santa Fe, New Mexico



CDM Camp Dresser & McKee
SF 40Year Figures.xls: Fig 2-5 1/10/2001

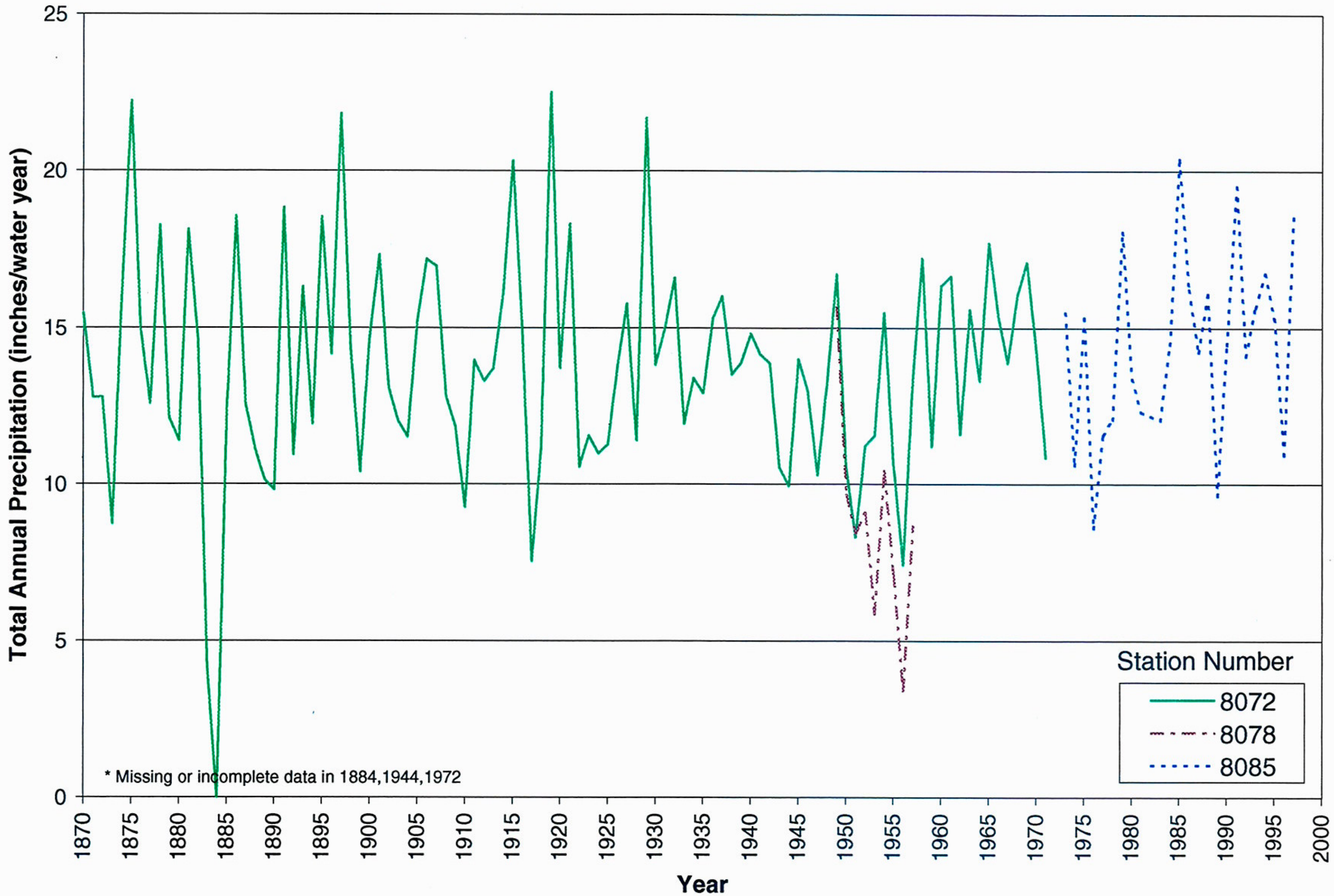
Figure 2-5
Diversions Allowed with Return Flow Credits

Number	Station Name	Latitude	Longitude	POR
08315480	Santa Fe R. above McClure Reservoir	35:41:20	105:19:17	1999-2000
08316000	Santa Fe R. at Santa Fe (between reservoirs)	35:41:12	105:50:35	1913-2000
08316505	Santa Fe R. below Nichols Reservoir, nr Santa	35:41:22	105:52:55	1998-2000
08316530	Santa Fe R. above St. Francis, at Santa Fe, NM	35:41:19	105:57:02	1998-2000
08316535	Santa Fe R. at Ricardo Rd. at Santa Fe, NM	35:40:44	105:58:27	1998-2000
08317200	Santa Fe R. above Cochiti	35:32:49	106:13:41	1970-1999



dend037 u:\projects\active\santafe\apr santafeworkingnew.apr NCDC and USGS layout 010201 scp

Figure 2-6
Map of Santa Fe Stream and Precipitation Gauges
Santa Fe, New Mexico



CDM Camp Dresser & McKee
precip.xls: Fig 2-7. 4/3/2001

Figure 2-7
Total Annual Precipitation

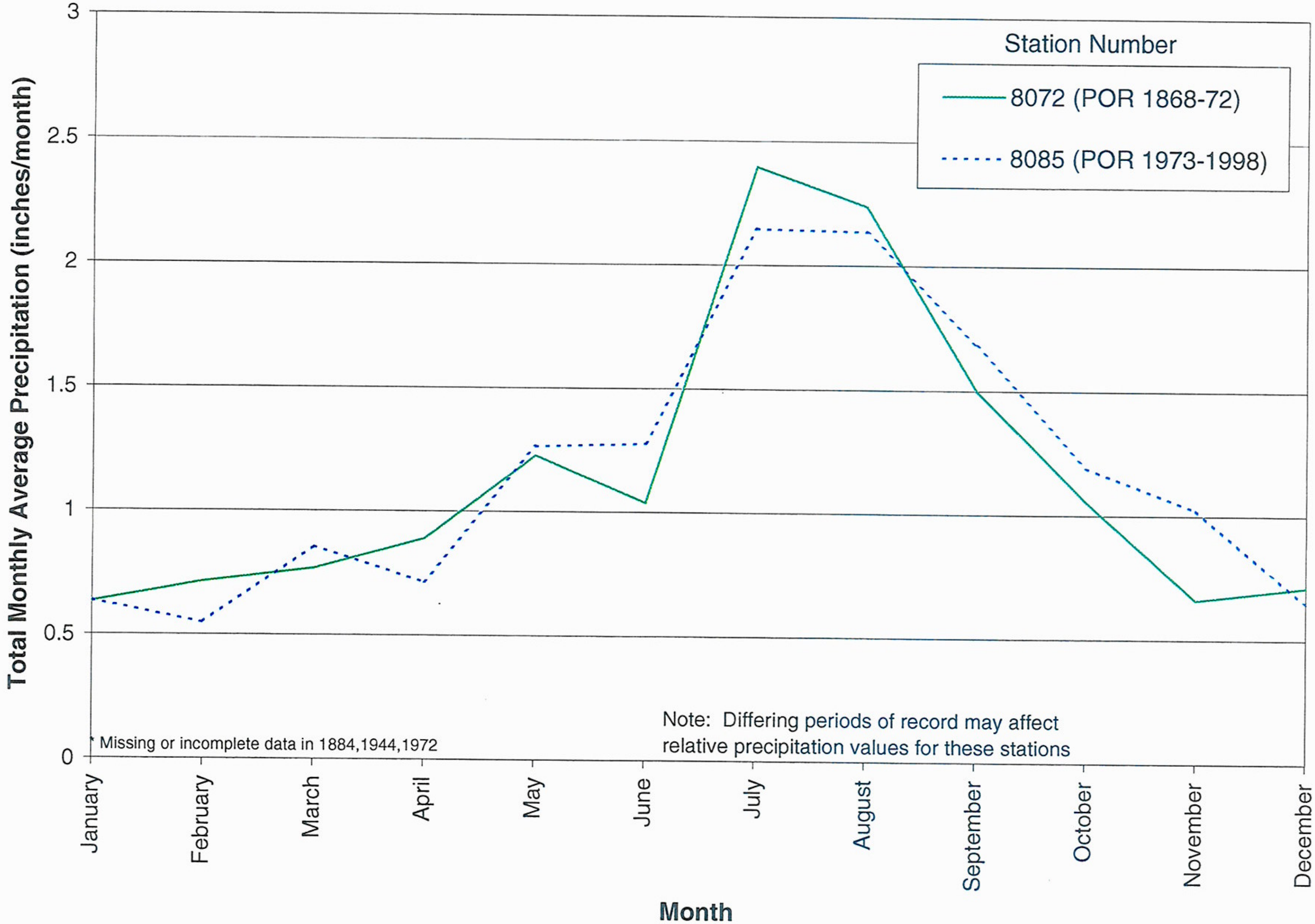


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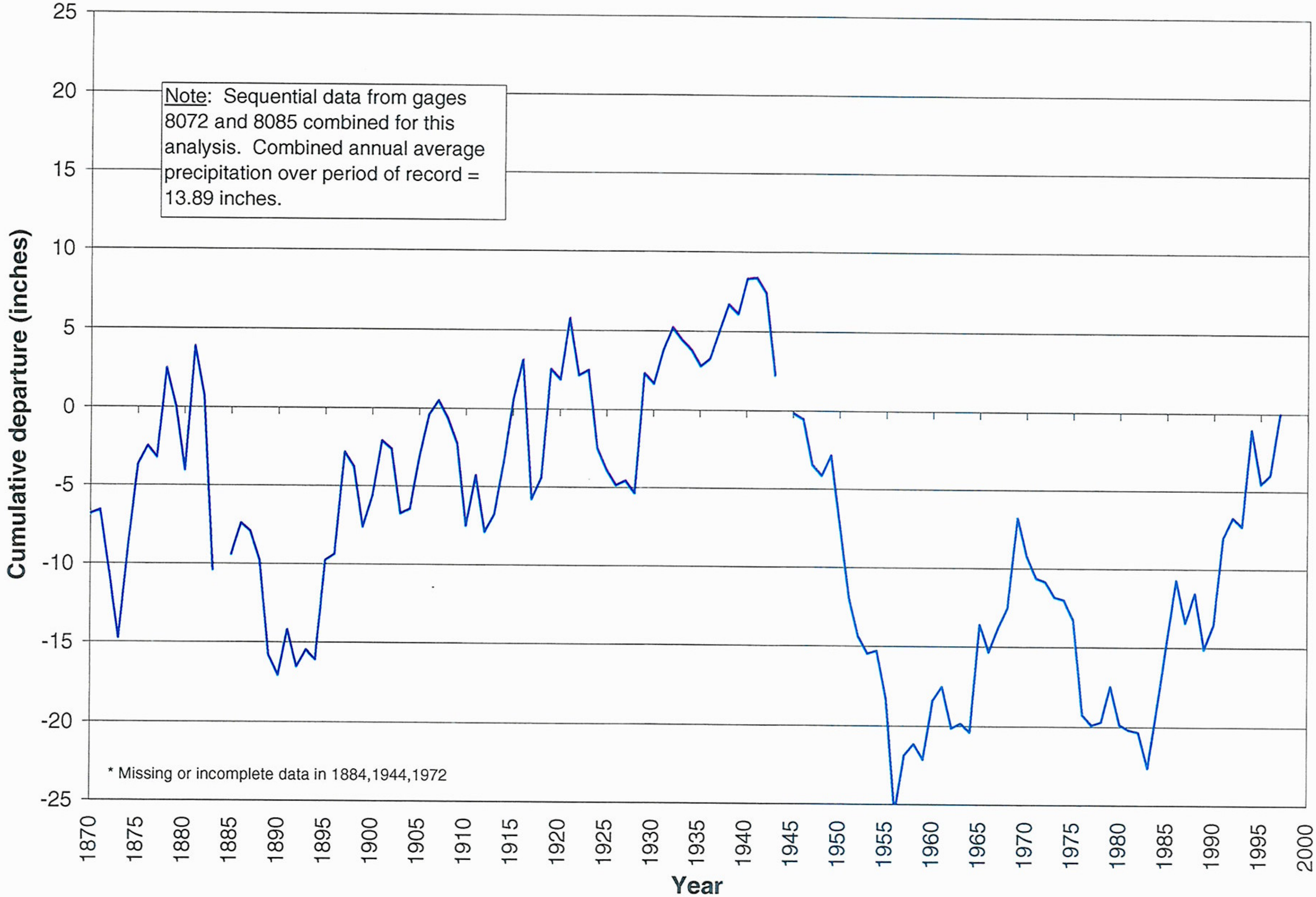
Figure 2-8
Monthly Average Precipitation over Period of Record



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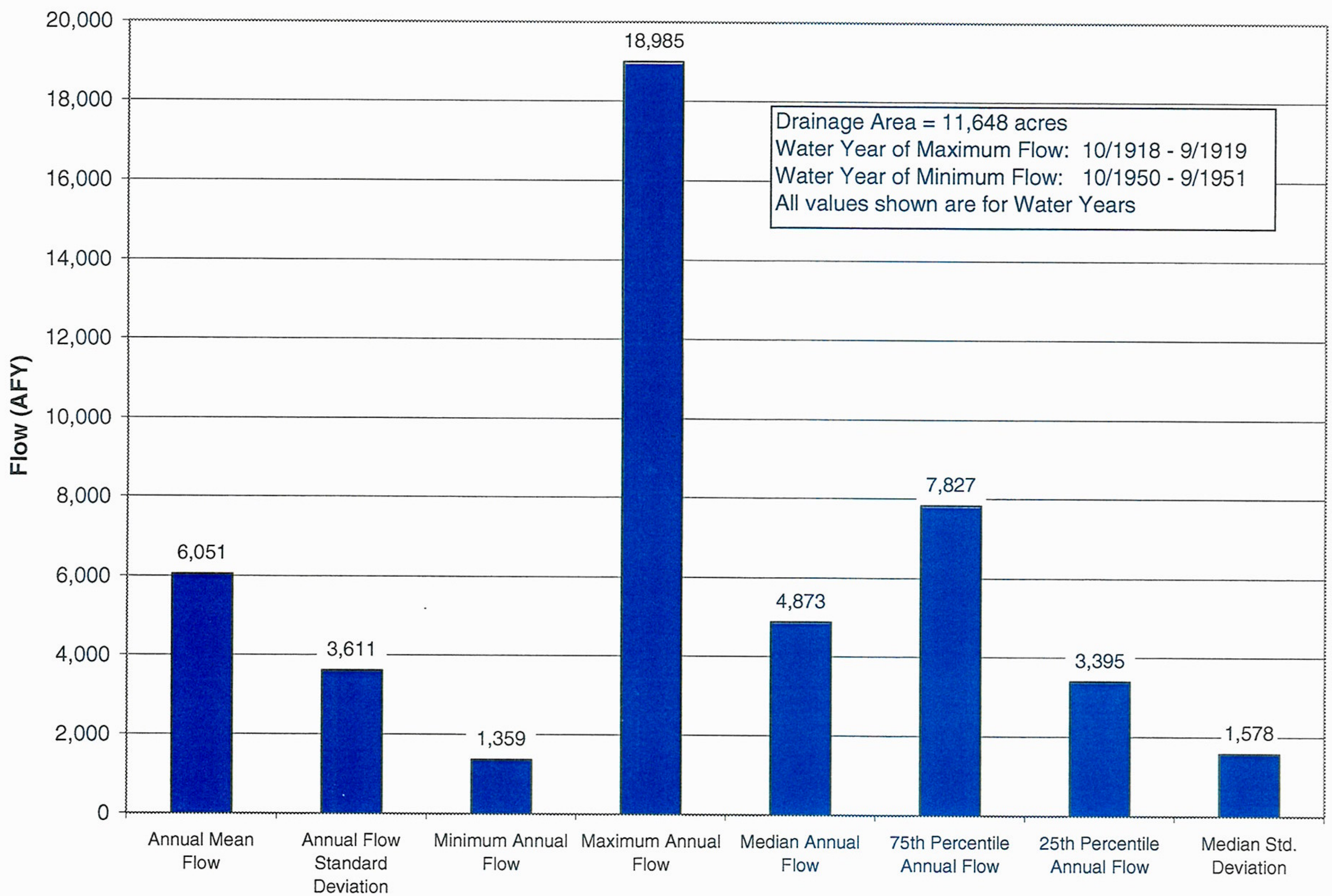
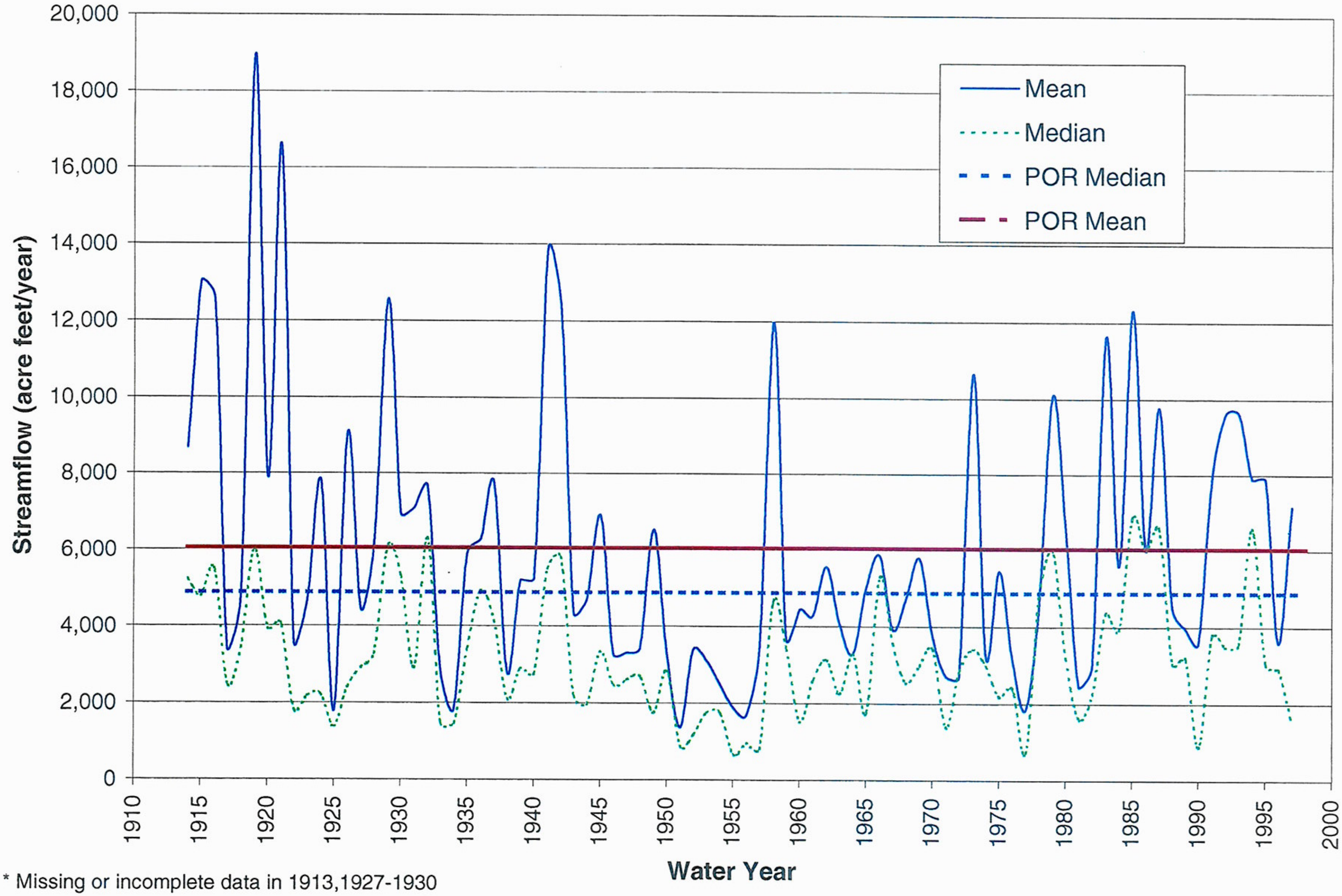
precip.xls: Fig 2-9. 1/10/2001

Figure 2-9
Cumulative Departure from Annual Average Precipitation
Gages 8072 and 8085



CDM Camp Dresser & McKee
flow.xls: Fig 2-10. 1/10/2001

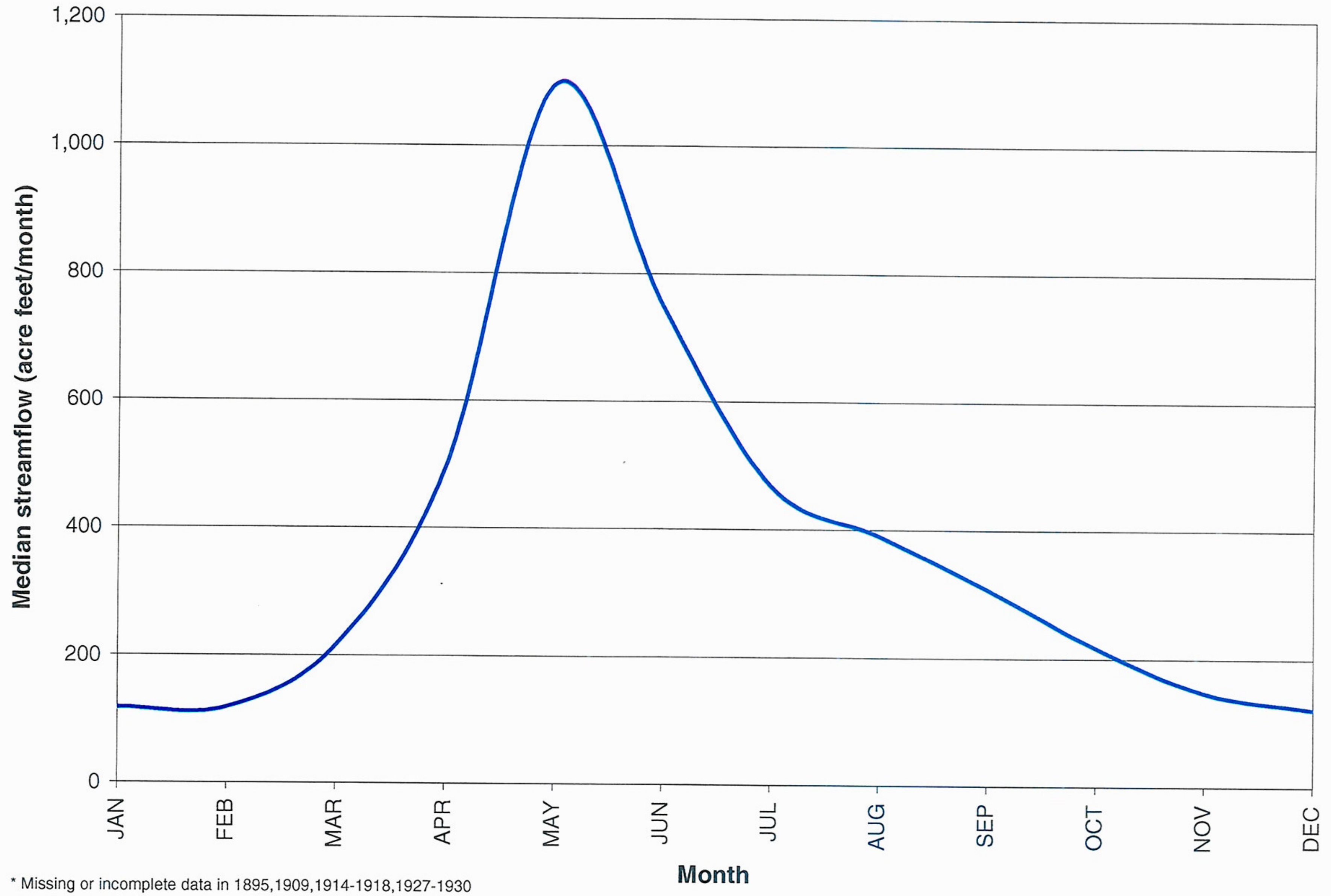
Figure 2-10
Summary of USGS Flow Gage 08316000 (Santa Fe R. betw. McClure & Nichols Resv.)
1913-1997



* Missing or incomplete data in 1913,1927-1930

Figure 2-11
Mean and Median Annual Streamflow for Water Years 1913-1997
USGS Gage 08316000 (Santa Fe R. betw. McClure & Nichols Resv.)

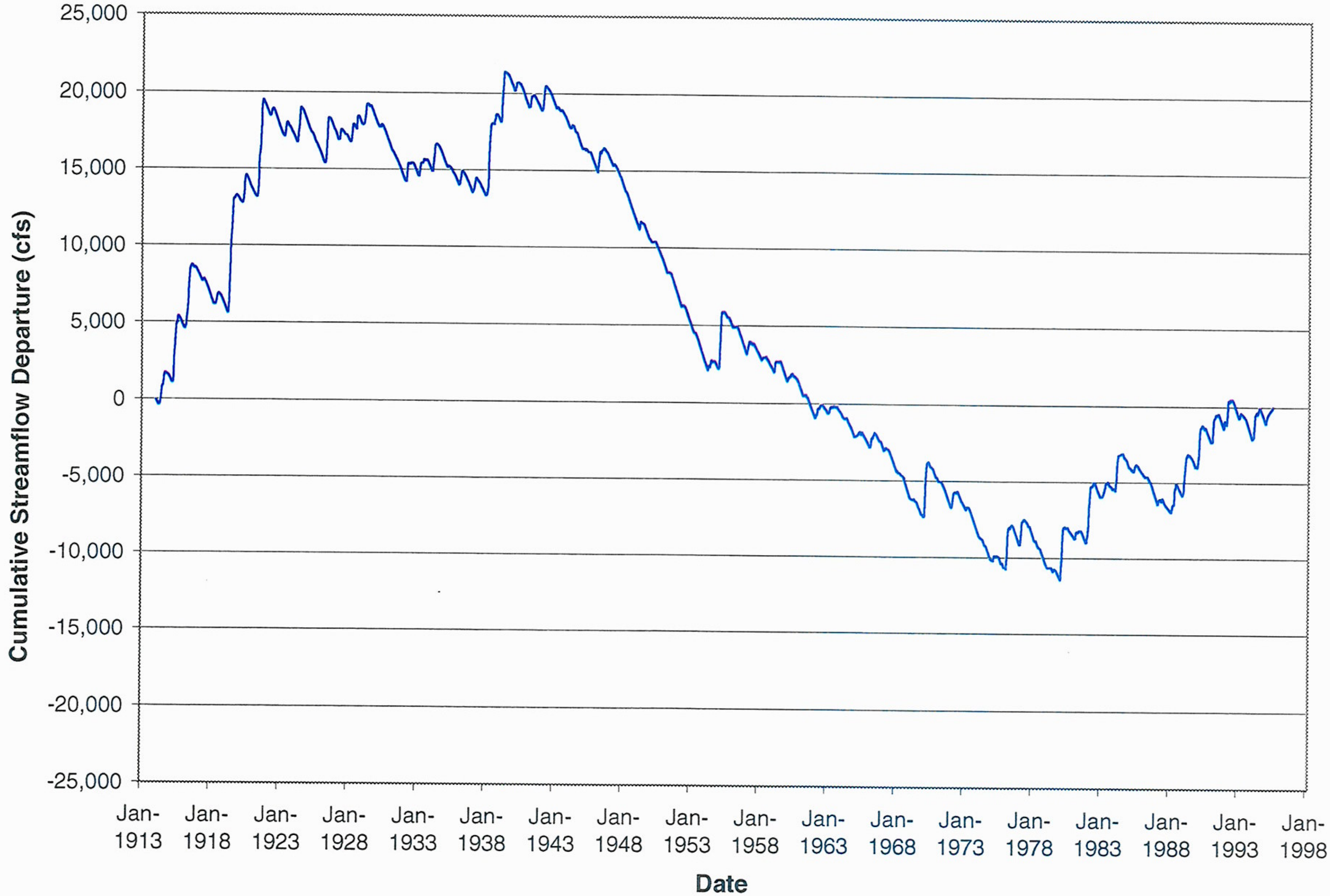
CDM Camp Dresser & McKee
flow.xls: Fig 2-11. 1/10/2001



* Missing or incomplete data in 1895,1909,1914-1918,1927-1930

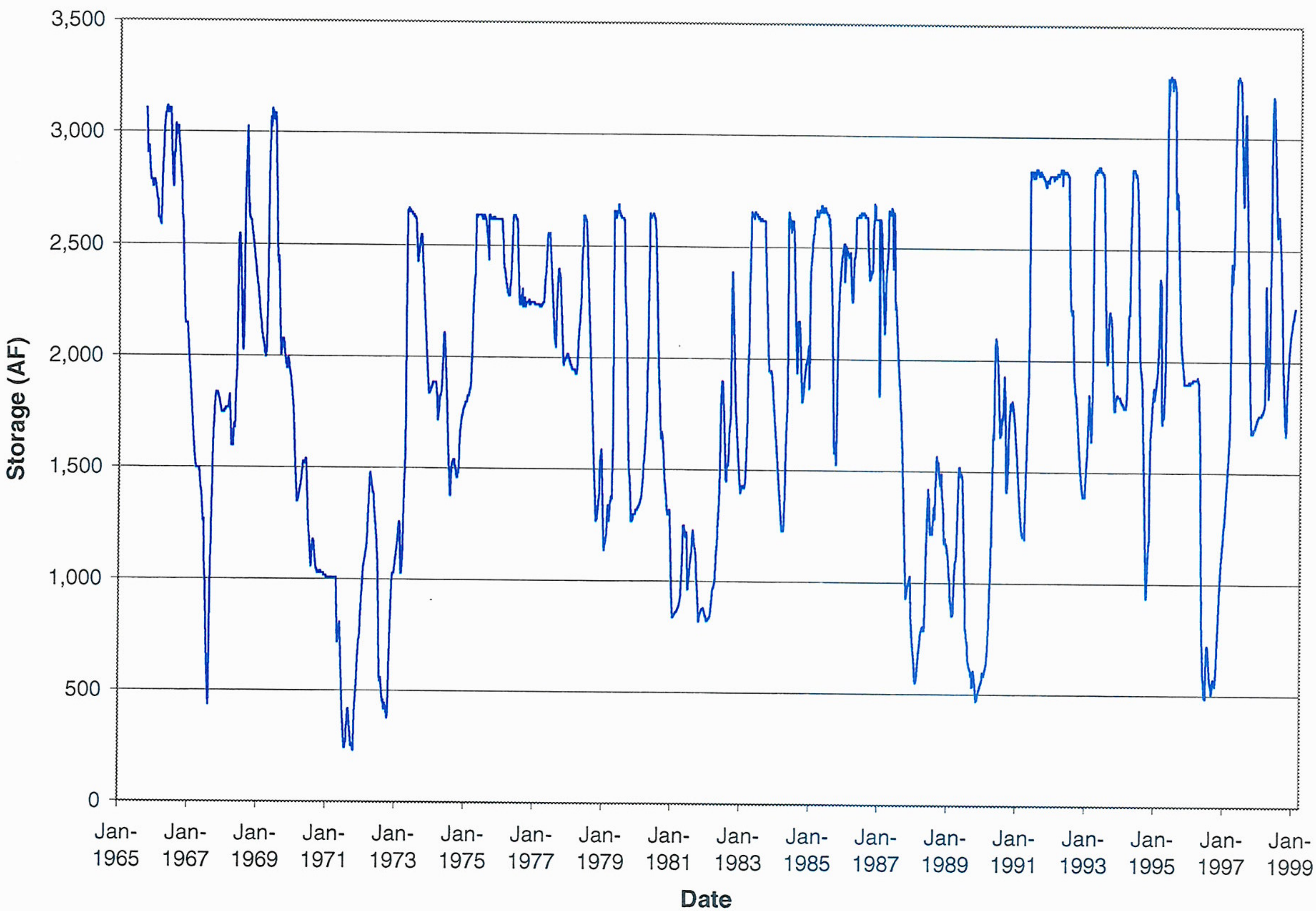
CDM Camp Dresser & McKee
flow.xls: Fig 2-12. 1/10/2001

Figure 2-12
Monthly Median Streamflow over Period of Record
Santa Fe River Gage 08316000 (Santa Fe R. between McClure & Nichols Resv.)



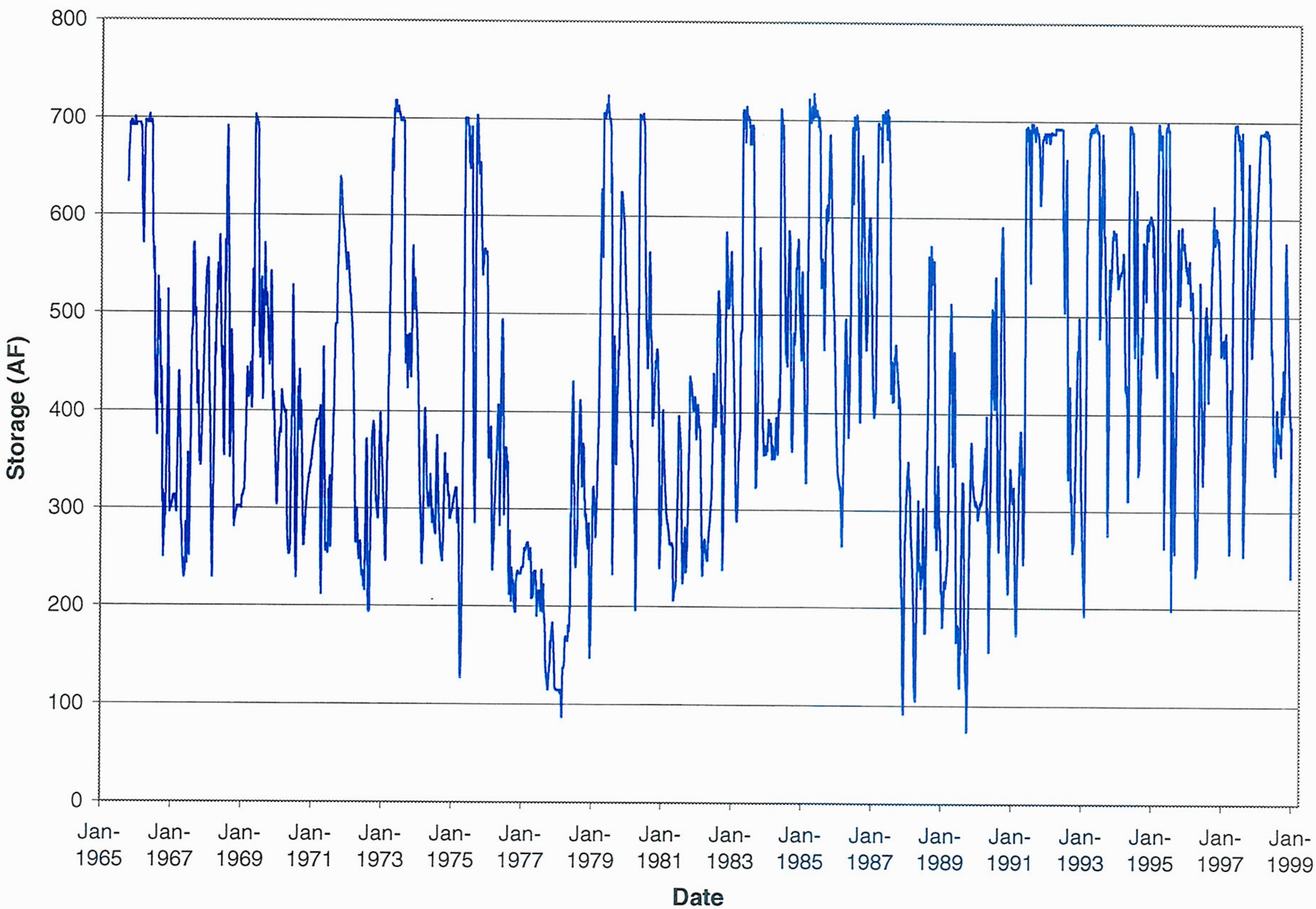
CDM Camp Dresser & McKee
flow.xls: Fig 2-13. 1/10/2001

Figure 2-13
Cumulative Departure of Daily Mean Flow from Overall Period of Record Daily Mean Flow
Gage 08316000 (Santa Fe R. betw. McClure & Nichols Reservoirs)



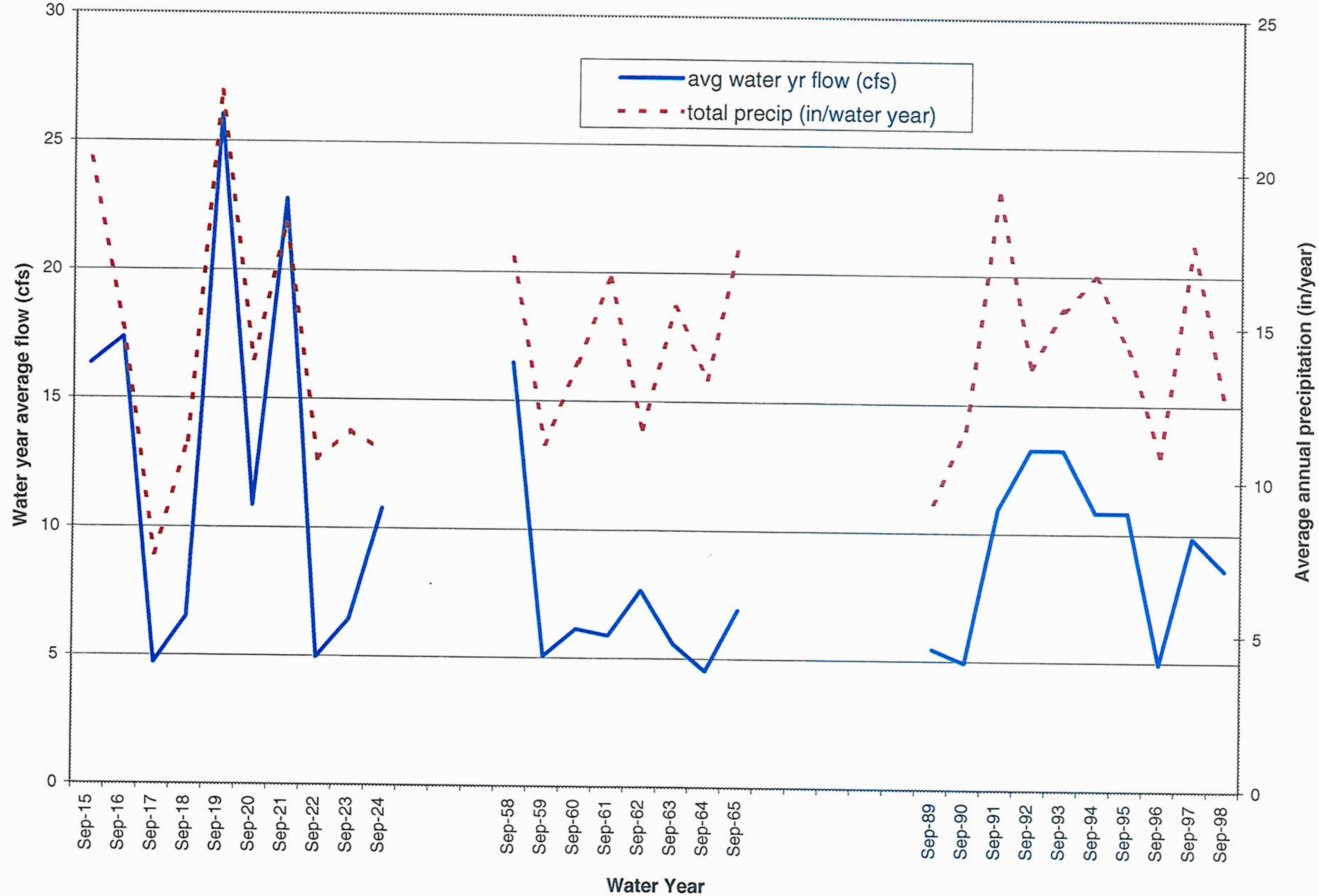
CDM Camp Dresser & McKee
mcclure-nichols-storage.xls: Fig 2-14. 1/10/2001

Figure 2-14
McClure Reservoir Measured Storage



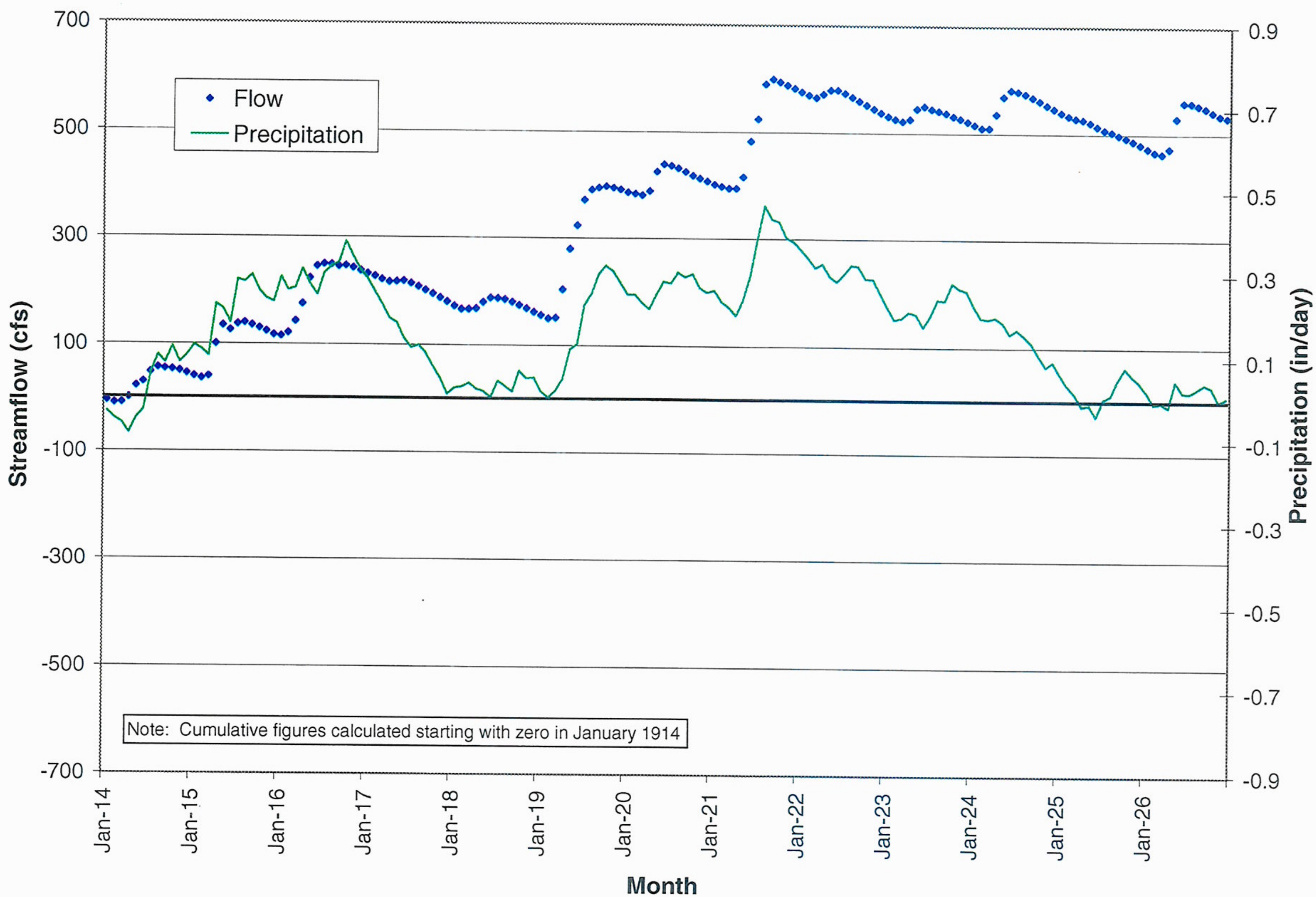
CDM Camp Dresser & McKee
mcclure-nichols-storage.xls: Fig 2-15. 1/10/2001

Figure 2-15
Nichols Reservoir Measured Storage



CDM Camp Dresser & McKee
precip.xls: Fig 2-16. 1/10/2001

Figure 2-16
Annual Precipitation (Station 8072)
vs. Santa Fe River Flow (Gage 08316000)



CDM Camp Dresser & McKee
precip.xls: Fig 2-17. 1/10/2001

Figure 2-17
Cumulative Departure from Mean Monthly Flow and Mean Daily Precipitation
Gages 08316000 and 8072, 1914-1926

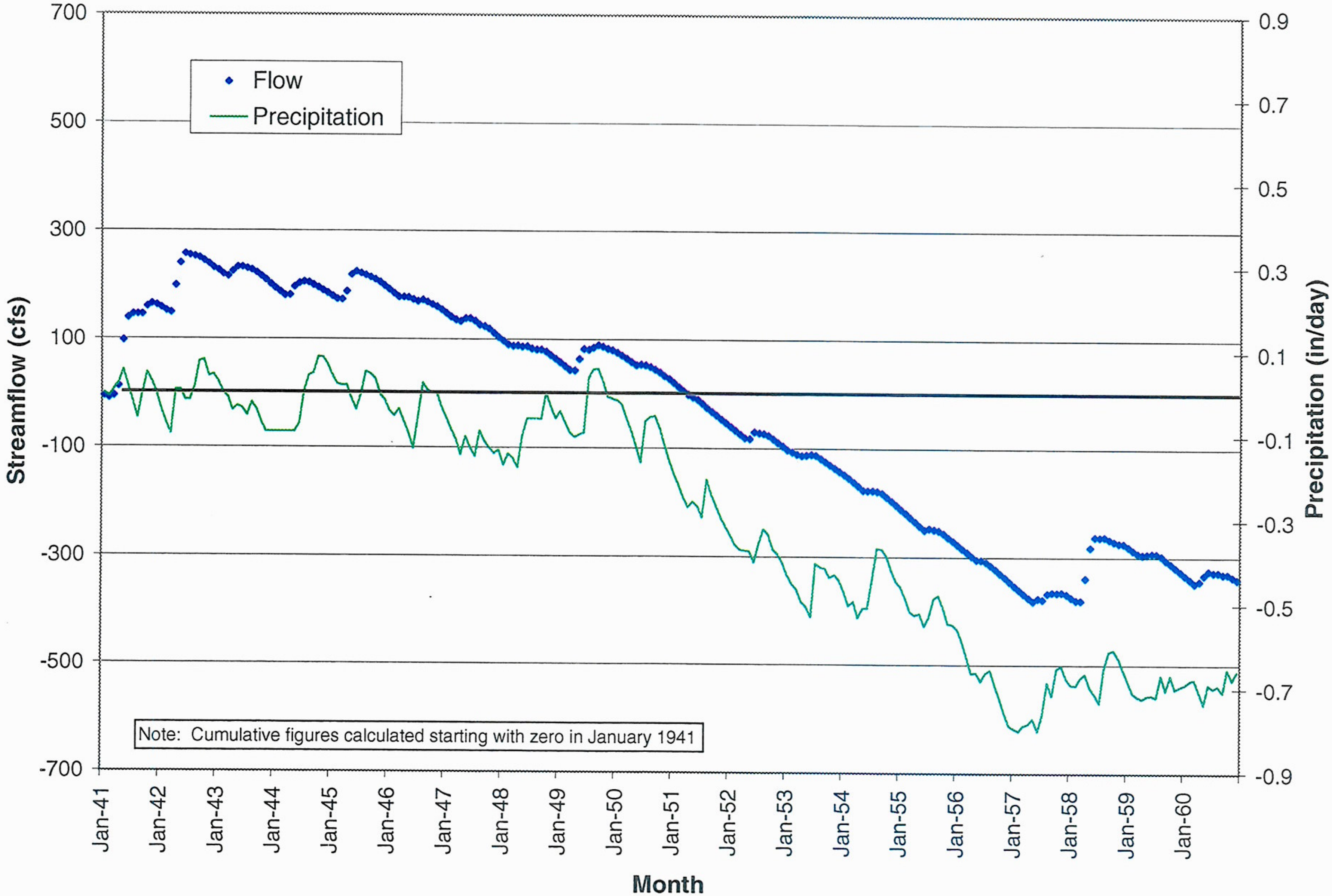


Figure 2-18
Cumulative Departure from Mean Monthly Flow and Mean Daily Precipitation
Gages 08316000 and 8072, 1941-1960

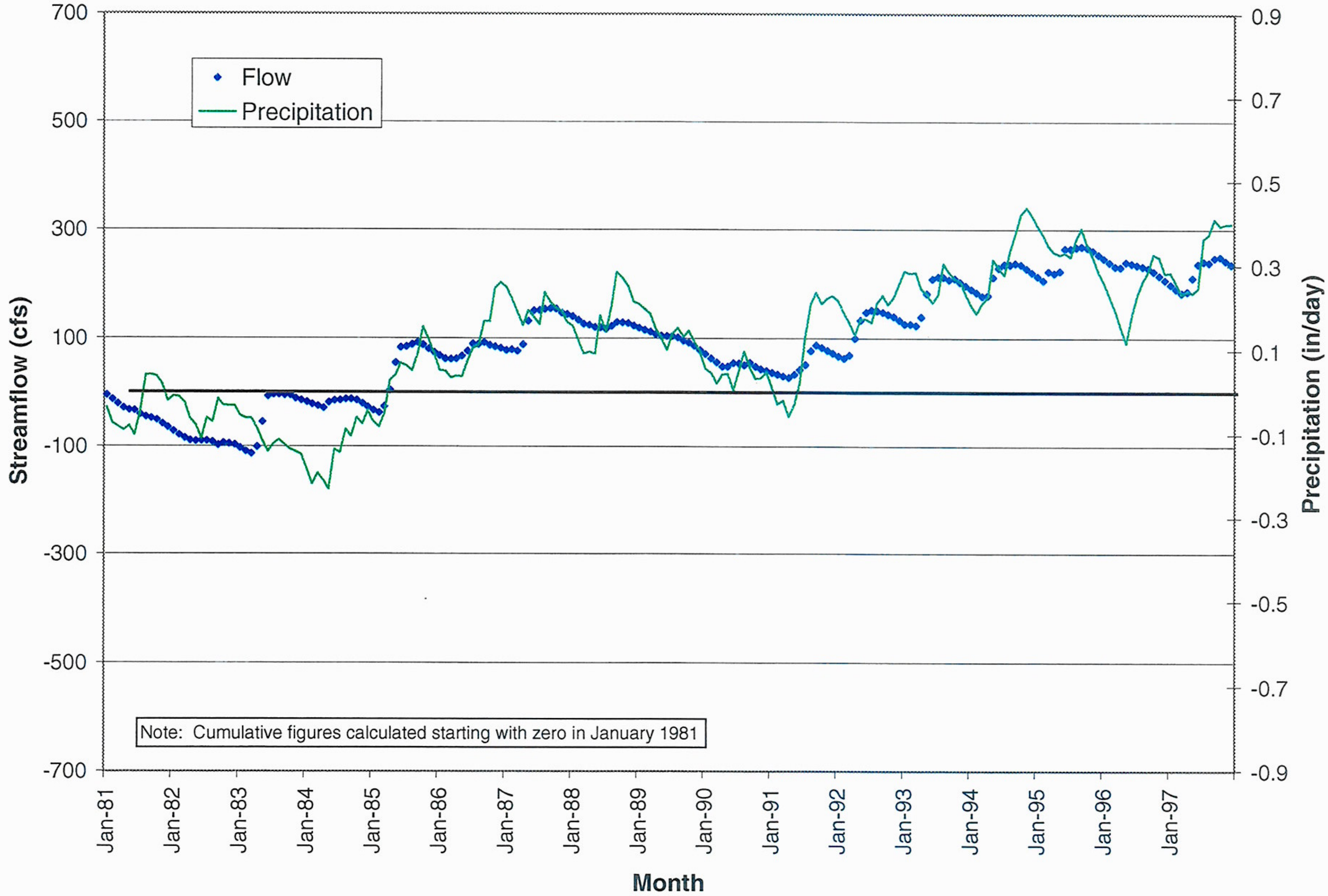


Figure 2-19
Cumulative Departure from Mean Monthly Flow and Mean Daily Precipitation
Gages 08316000 and 8072, 1981-1997

CDM Camp Dresser & McKee
precip.xls: Fig 2-19. 1/10/2001

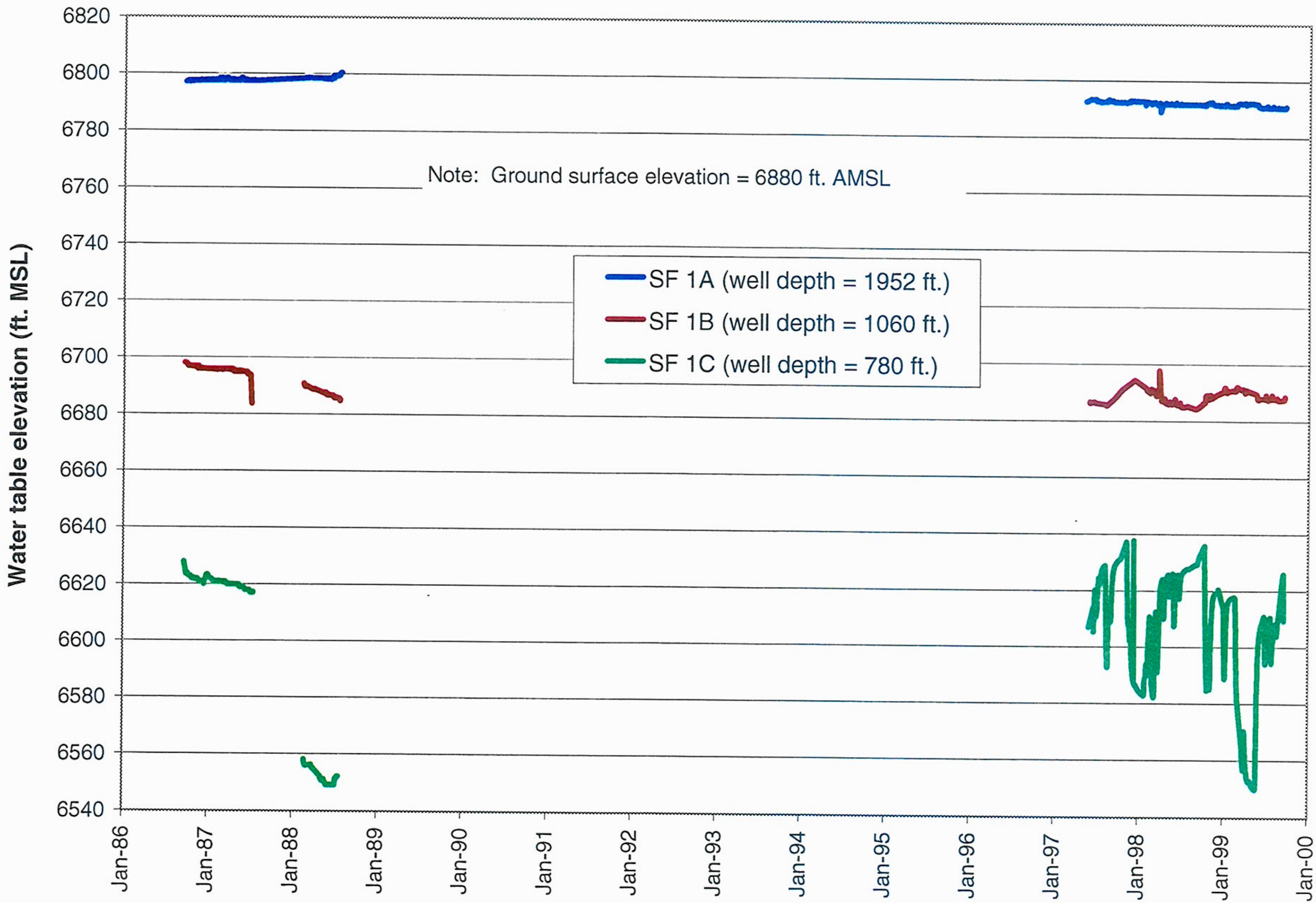


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Figure 2-20
Water Table Elevations at SF-1 Wells

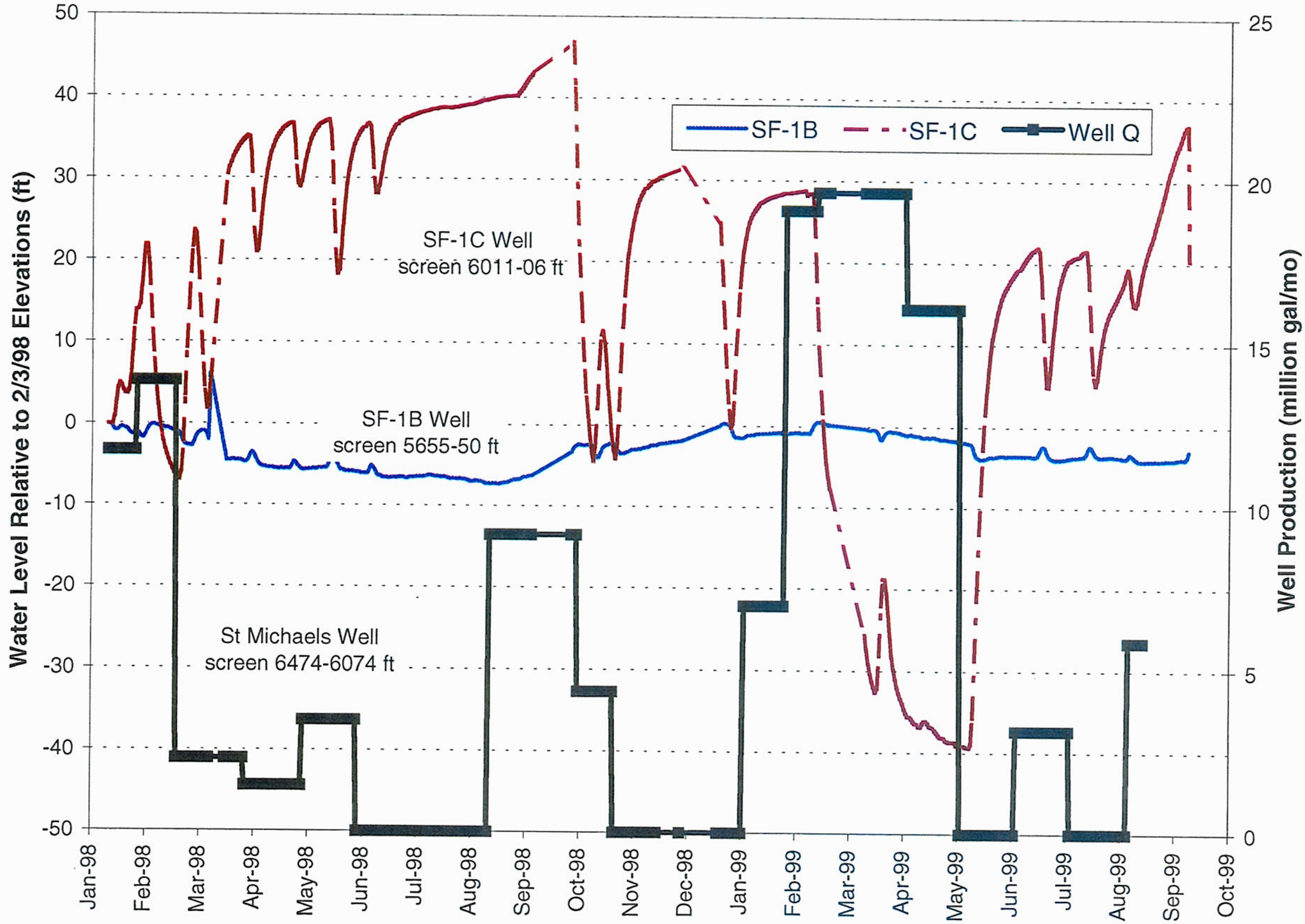

Figure 2-21
Water Levels and Well Production
SF-1B, SF-1C and St Michael's Well

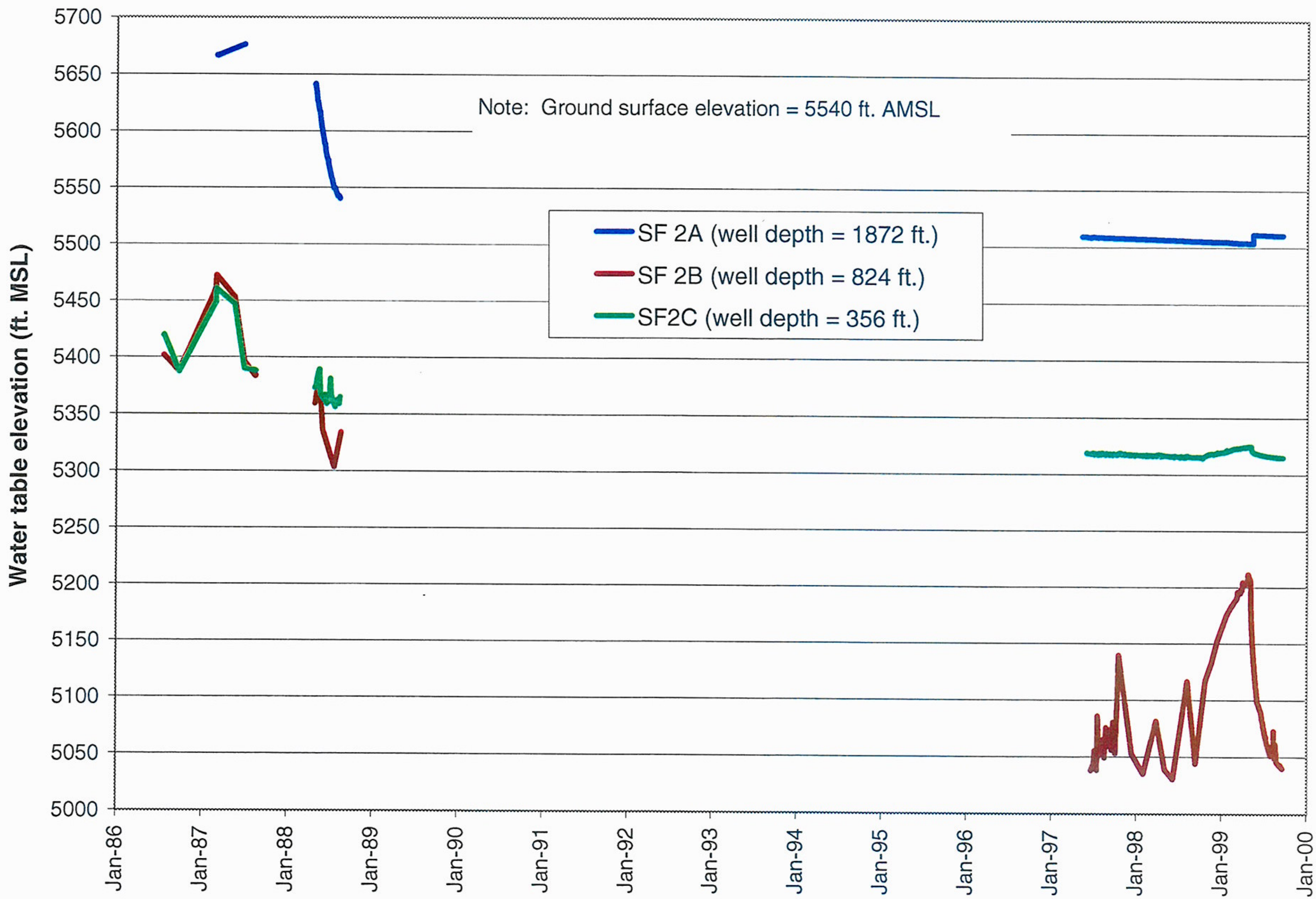

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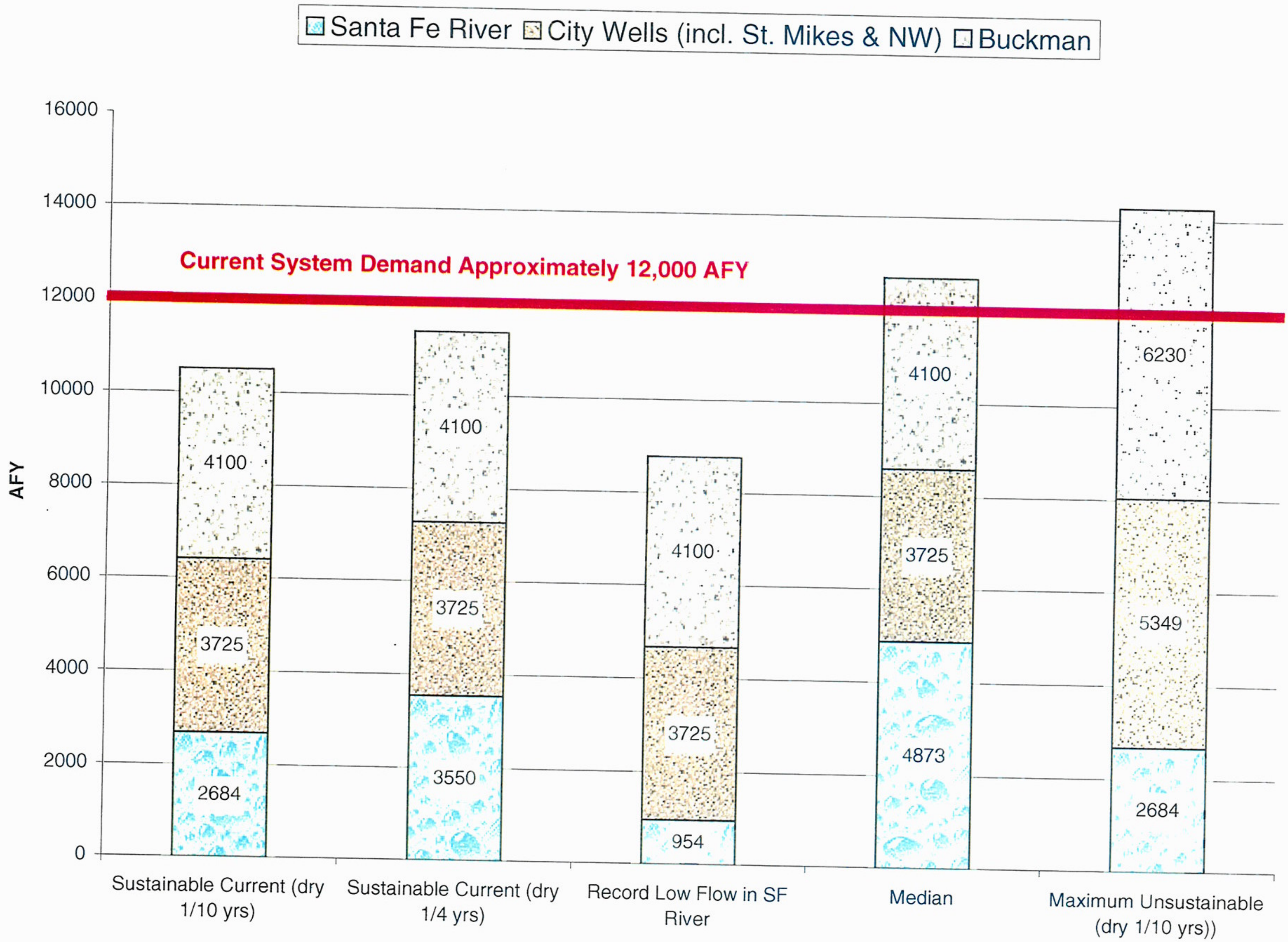
Figure 2-22
Water Table Elevations at SF-2 Wells



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SDCW Diversions Historical.xls Fig 2-23

Figure 2-23
Current Annual Supply Capacity of Sangre de Cristo Water

Section 3
Historical and Projected Water Demands

Demands for water come from SDCW's residential, commercial, and industrial customers in the SDCW service area. Additional demands for water are generated by the four acequias served by the SDCW system. SDCW must manage its water supplies to meet these demands. Demands can vary on an hourly, daily, seasonal, and year-to-year basis. The focus of the 40-Year Water Plan is on annual water demands to ensure long-term availability of the required water quantities. However, daily operation of the system must account for these various peaking factors. In this section, historical and recent demands are summarized, and estimates are made of future water demands. The projected demands are subsequently compared to the existing capacities of the SDCW system.

3.1 Historical Demands

An overview of historical demands in Santa Fe is provided in this section. This provides insight into past and recent trends in water demands.

3.1.1 Overview of Demands

Historical demands were discussed in Section 2.1, shown graphically from 1948 to 1999 in Figure 2-2 by source of supply. Table 3-1 presents the last 10 years of production data, plus recent data on the portion of total production that is delivered to Santa Fe County and Las Campanas.

Table 3-1 Water Demands in Santa Fe, 1990-1999

	Production (AFY)					Demands (AFY)	
Year	Santa Fe River[1]	St. Michaels	Buckman Wells	City Wells	Total Production	Las Campanas	Santa Fe County
1990	3,889	387	3,824	2,598	10,697		
1991	4,980	61	3,186	2,367	10,593		
1992	4,832	141	4,752	2,107	11,832		
1993	5,008	32	5,610	1,995	12,645		
1994	5,429	84	4,982	1,970	12,464		
1995	5,264	102	5,891	1,924	13,180		
1996	2,682	677	5,656	1,902	10,917	515	5
1997	5,383	218	4,716	1,024	11,340	501	40
1998	4,597	197	5,216	2,074	12,084	758	75
1999	4,303	252	5,273	2,549	12,383	893	80

1 Excluding St. Michael's Well

The drought conditions of 1996 and 2000 significantly reduced the amount of runoff available in the Santa Fe River Canyon. Mandatory conservation measures implemented in response produced a marked drop in demand. In 1997, after normal precipitation resumed and the 1996 conservation measures were discontinued, the Santa Fe River supply returned to normal but demands remained relatively low. This may be the result of community members becoming temporarily accustomed to using water-efficient practices. In 1996, the City was forced to rely more heavily on groundwater from the city wells and imported water from Buckman. In 1997, with more local surface water available, the City was able to reduce its use of groundwater and Buckman water. Higher demands fitting the pre-1996 pattern returned in 1998.

These data demonstrate the ability of the City to temporarily restrict demands using intensive conservation measures. However, it is clear that the City's ability to reliably supply about 12,000 AFY of potable water (depending on precipitation and surface water runoff, as discussed in Section 2) is only marginally capable of meeting current demands. Without additional supply capabilities, further growth in demand will render the City unable to meet future demands, especially in times of drought or low surface water availability.

3.2 Factors Affecting Demands

Demand rates are often expressed in terms of volume per capita per day, or volume per dwelling unit per day, incorporating all types of demands (e.g., commercial, industrial, and residential) into a single unit demand. However, unit demand rates are affected by a number of community-specific factors, and can differ significantly from one city to another. To varying degrees, some of these demand factors can be influenced by city policy. A discussion of some of the factors affecting demands follows.

3.2.1 Community Characteristics

The amount and type of users in the industrial, commercial, and residential community can affect water use patterns significantly. For example, the presence of a high-tech manufacturing facility that uses high volumes of water in its process can increase "per capita" usage rates significantly. Land ownership and use types can also affect water use. The arid climate in Santa Fe can result in a high rate of outdoor watering of non-native plant species in residential areas. Higher density residential areas may tend to have lower outdoor watering needs, reducing the per capita demands.

3.2.2 Regional Issues and Partnerships

Per capita consumption is unlikely to be significantly affected by the presence or absence of partnerships between the City and its neighbors. However, the total demand on the City's system could be affected by connecting its distribution system with that of one or more of its neighbors. Similarly, the decision between providing City water to a new development versus the use of individual domestic wells can have substantial demand implications for the City's system.

3.2.3 Conservation Programs

SDCW has integrated conservation and water-wise practices into its operations for many years, with an intensified focus in recent years. There are clear economic and water supply benefits to making the most efficient use of the limited water that is available. SDCW's current and ongoing conservation program is discussed in detail in Section 4. Because it is an ongoing program, the benefits and water savings of this program are integral to the current rates of water consumption in Santa Fe.

The emergency conservation measures implemented during the drought conditions of 1996 highlighted SDCW's ability to reduce water consumption. Primarily in response to these measures, water consumption in the SDCW service area dropped 13 percent in 1996 from the previous year while the population increased slightly.

3.2.4 Rate Structures

Water consumption can also be influenced by rates. Higher rates, or tiered rates, have been demonstrated to encourage conservation in a number of communities. Santa Fe's rates are set up to encourage conservation. A copy of the current rate structure for the City of Santa Fe is included in Appendix E.

3.3 Operation and Maintenance Considerations in Providing Potable Water

3.3.1 Overview

Many factors enter into source selection and production; however, the availability of Santa Fe River water is the primary controlling parameter. Economics also are an important element in source production management. When setting targets, sustainable yield and surface water rights must be considered.

Previous evaluations have indicated that the Santa Fe River surface water source (excluding St. Michael's Well) is the most economical source, and the least economical source is the Buckman Wells. Buckman is more expensive due to the costs associated with pumping the water over the ridge and into town. Santa Fe River water is also more attractive from a "renewability" and sustainability point of view.

Thus, from an economic standpoint, the preferred order of source production is: Santa Fe River, City Wells, and then the Buckman Wells. However, given the level of current demand, coupled with supply limitations discussed in Section 2, all three sources are needed every year. Depending on the demand level and surface water availability in a given year, the City can shift its use towards one supply (e.g., use more groundwater in a dry year).

In the spring of each year, snowpack data is modeled and analyzed to determine anticipated runoff. The model compares the moisture content of the snowpack (inches of water) and the timing with historical records to predict runoff. Once the runoff has been predicted, production source targets are established. This information is used to establish targets for each of the sources during the next season.

3.3.2 Considerations for Production Deliveries

The water supply production system is operated as economically as possible while meeting system demands from the available sources of water. A long-term water supply plan is established annually. Projections of available water supply, especially of surface water, are made to meet projected demands. The long-term plan is continually revised as demand or supply conditions warrant.

The production system is operated to meet both daily conditions as well as long-term production. The production system capacity is limited, and all of the production system is required to meet peak demands. System demand can vary, depending largely on weather conditions. High system demand occurs between May and October with peak days usually occurring in late June and early July. The production system is operated to utilize the most economic supply source in conjunction with the overall long-term supply plan. On-peak and off-peak energy costs, both gas and electric, influence the economic considerations for each source.

Water supply production system capacity depends on the physical production capacity of the production system works, the actual water yield available in the watershed and aquifers, the right to use the water, and other issues such as water quality, regulatory constraints, and system reliability. The three supply sources' production, and the production capability for each source was summarized in Section 2.

Past evaluations conducted by SDCW have indicated that the relative costs of each source of supply, starting with the least expensive source, were as follows:

- Surface Supply (not including St. Michael's Well)
- City Wells (not including those with advanced treatment)
- Buckman Wells
- City Wells with advanced treatment

The least cost source is the surface water. Treatment costs account for the majority of the cost of water production as there is very little pumping because the treatment plant is supplied by gravity feed. The City Well Field sources have historically been the next least expensive due to the fact that they pump directly into the distribution system. Energy for pumping is a significant portion of the overall production costs. The Buckman Well Field source is very energy intensive because water must be pumped an additional 2,000 feet in elevation. Energy costs are a significant portion of the overall production cost. The production costs for City Wells with advanced treatment are higher due to the additional mechanical equipment required, such as blowers for the air stripping units. In addition, any recharging/regeneration of granular activated carbon (GAC) adsorption units increase the treatment costs.

The production costs listed above are based on previously developed costs and are presented only for information as to the relative production costs for each source. To help prioritize the use of water supply sources, SDCW should regularly update these costs.

3.3.3 Water Quality Monitoring

SDCW follows all federal and state requirements for monitoring its treated water. Each year, SDCW prepares a Water Quality Report that is available for public review. This report summarizes enhancements and improvements to the system, provides an overview of water sources, and discusses contaminants of potential concern in drinking water supplies (including new or modified regulations). A summary of key water quality data is also provided in the report. An example of SDCW's annual Water Quality Report is included in Appendix F.

3.3.4 Water Use Tracking

Accurate and complete reporting is essential in the management of the City's water supply. A computer-based reporting system has been in place for many years, and in 1996, the system was converted from a mainframe program to a PC-based program located at the WTP. The program is based on a commercially available database program and produces monthly, weekly, and daily production and consumption reports. The system also produces correspondence for the State Engineer that is required by state regulations.

Monthly. The monthly report presents information for production as well as consumption in both AF as well as million gallons. The production is reported for all sources including wells and surface runoff. Reservoir storage is reported as well as Acequia deliveries. Year-to-date information is given as well as previous year data.

Weekly. Weekly reporting shows surface runoff and reservoir status. Inflow into the reservoirs (surface runoff) is reported, as well as reservoir storage volume, reported in both AF and million gallons. System production and consumption is also reported. This report is extremely valuable in that it reports water right status for all sources, thus providing the required information to SDCW for their management. The year-to-date use of the water right allocation is given along with the percent of allocation consumed.

Daily. The daily report displays source production and system area use. The volumes are reported in AF and million gallons. Water storage tank status is also reported and is a valuable tool for the system operators in daily management of the distribution system.

Status and projections. The reporting system provides valuable tools for managing the water supply. City staff can modify annual targets as needed based on accurate, up-to-date information. The reporting system stores a minimum of a decade of data for water accounting purposes as well as for use in demand projections. The database system allows sophisticated manipulation of the data, and because it is programmed in a commonly known "language," program modifications are easily accomplished.

3.3.5 Contingency Plan

Recognizing that severe drought conditions or unforeseen circumstances could limit the City's ability to provide water, SDCW prepared the Supply Shortage Emergency Action Plan (SSEAP) in 1996. The SSEAP establishes a methodology for daily evaluation of the source of supply relative to anticipated demands, identifies available water sources and methods of delivery, and identifies SDCW actions needed and plans for the implementation of emergency services and agencies as needed.

The three levels of response outlined in the SSEAP include, in increasing order of severity:

- The Alert Step Plan
- The Warning Step Plan
- The Emergency Step Plan

Critical storage is defined in the plan as follows:

- Total system distribution storage at 1/3 of total distribution storage available
- Minimum distribution storage at 1/3 capacity in the following tanks: Hydro, St. John's, Buckman, Hospital, and SW Tank
- Minimum distribution storage at 1/2 capacity in the following tanks: Summit, Dempsey, and East High Level Tank

The Alert and Warning levels are reached when there are an estimated 72 hours and 24 hours to critical storage, respectively. The Emergency level is triggered when critical storage has been released. The full SSEAP, showing details of the actions required at each level, is on file at the SDCW offices.

3.4 Projected Future Demands

To evaluate alternatives for future water supply and management, the availability of existing sources of raw water must be compared to projected demands. For Santa Fe, regional demands are expected to increase at a faster rate than those of the City due to the anticipated trends in population growth. Complicating this analysis is the uncertainty in population projections and the developing nature of regional water partnerships. Presently, it is unclear which entities or areas in the region will ultimately be served by a common supply, treatment, and distribution network.

3.4.1 Basis of Analysis

Starting water demands and population figures (i.e., in 2000) were estimated based on recent history and City data. Water demand projections are based on the highest population growth projections in the City's General Plan, which extend to 2020. The General Plan's growth projections were based on the Santa Fe County Population and Housing Study (Prior 1994). From 2021 to 2040, it was conservatively assumed that population and water demand growth rates would continue at the same rate (i.e., annual percent) as in 2020. This is a moderately conservative approach in estimating water demand, since growth is unlikely to continue at a constant percentage rate in later years. Rather, a constant rate of increase in demand (e.g., AFY) may be observed.

For regional demands, population numbers were split out for total regional population versus that portion of the total population that is connected to the SDCW water system. Based on input from SDCW staff, it was assumed that in 2000, 5 percent of the regional population outside the urban area is connected to the system. Over time, it is assumed that 50 percent of the regional population outside the urban area will be connected to the SDCW system. In this analysis, the increase from 5 percent to 50 percent is phased in over the course of the 40-year planning period. Population values used for projecting water demands are summarized in Figure 3-1.

Based on historical use data, it is projected that the annual average usage per dwelling unit (DU) will be 0.4 AF. This value incorporates commercial water uses and system losses. It also assumes that conservation will be encouraged at a moderate level under the City's ongoing water conservation program. Emergency demand reduction measures could be implemented during prolonged dry periods, which would be expected to reduce demand toward 0.25 AF/DU/year, as was accomplished during the summers of 1996 and 2000. However, these measures induce a significant hardship on the community.

An average of 2.0 persons per DU was used in the analysis. While estimates in Santa Fe of as high as 2.3 persons per DU have been discussed, the 2.0 figure provides a reasonable level of conservatism in estimating water use on the high side.

Water demands have been calculated for both the Urban Area and the Santa Fe Region (as defined in the General Plan). It is assumed for this analysis that new growth in the greater Santa Fe area will be served by the water system. This assumption is consistent with the City's policy of restricting domestic groundwater well use.

The City's General Plan strongly supports the City's participation in a regional water system, noting that:

> *1) [T]he groundwater resources are finite and the consequences of their continued mining could be disastrous, 2) a soundly designed "regional" water system achieved in cooperation with our immediate neighbors is a necessity more than an option. Most residents of this "region" should be served by a central water system for the purposes of consistent long-term quality and protection of the groundwater resources that supply their needs, 3) because the regional approach contributes to securing supply sources for a large number of people, it also helps in reducing the per-capita cost of the necessary infrastructure.*

3.4.2 Projected Demands

Projected water demands for the Urban Area and Santa Fe Region are presented in Figure 3-2. Calculations supporting these estimates are shown in Appendix D. The actual demand on the regional potable water system that is envisioned will depend on the degree to which regional partnerships are developed and private well users convert their source of supply to the system. The actual demand on the regional water system in any given year will likely fall between the two curves shown in this plot. Alternatively, if no partnerships are formed, the demands on the SDCW system will be in the range of those shown for the "urban area" demands.

3.5 Comparison of Projected Demands to Existing Available Supplies

Table 3-2 summarizes the water supply scenarios currently available to the City, based on the analyses presented in Section 2. The City can presently supply between 11,000 and 12,000 AFY during a dry "planning year" if operating the Buckman Well Field and City Well Field in a sustainable manner (i.e., at 5,000 AFY and 3,725 AFY, respectively). After subtracting out estimated demands for Santa Fe County and Las Campanas, only 10,000 to 11,000 AFY is available for the City. In comparison to Figure 3-2, it is clear that the present ability to sustainably supply water under these conditions is only marginally capable of meeting current demands and will fall far short of meeting future urban area or regional demands. Moreover, these values are somewhat optimistic in that they do not account for infrastructure failures, and also presume that the Northwest well will be permitted.

Table 3-2 Summary Of Existing Supply Scenarios (After Supplying Santa Fe County and Las Campanas) [1]

	Planning Scenario (1-in-10 Year Drought)	Maximum Supply (wet year)	Planning Scenario (1-in-4 Year Drought)
Sustainable	10,034 AFY	12,390 AFY	10,900 AFY
Nonsustainable	13,784 AFY	15,660 AFY	14,650 AFY

[1] Combined demand for Santa Fe County plus Las Campanas estimated at 1,375 AFY

In the interim, Buckman can be pumped at a higher rate, since the infrastructure is in place to deliver about 7,000 AFY from this source. This will alleviate part of the problem. With additional City Well Field improvements in place as planned, the City wells will be able to deliver the full water right of 4,865 AFY.

If Buckman were to be pumped at 7,000 AFY and City Well Field improvements were completed such that the full 4,865 AFY of water rights could be used, the City's total (nonsustainable) supply would instead be between 15,000 and 16,000 AFY. After subtracting out estimated demands for Santa Fe County and Las Campanas, available supplies to the City would be 13,800 to 14,700 AFY. From Figure 3-2, it can be seen that this would extend the City's ability to meet urban area demands to between about 2008 and 2017. Additional pumping and conveyance infrastructure for the Buckman Well supply would allow pumping up to the 10,000 AFY permit limit (assuming sufficient offsetting water rights were available, based on the offset ratio at that time). This would further extend the ability of the City to supply growing urban area demands to between about 2023 and 2035.

However, based on the current understanding of the hydrogeologic characteristics, it appears that pumping of Buckman in excess of 5,000 AFY on average is not sustainable, nor is pumping of the City Well Field (including St. Michael's Well) above 3,725 AFY on average in its current configuration without additional aquifer recharge. Because one of the central principles in the City's water supply planning efforts is increased sustainability, alternatives to the use of these increased Buckman and City Well pumping rates to meet the growing demands are presented in Section 4.

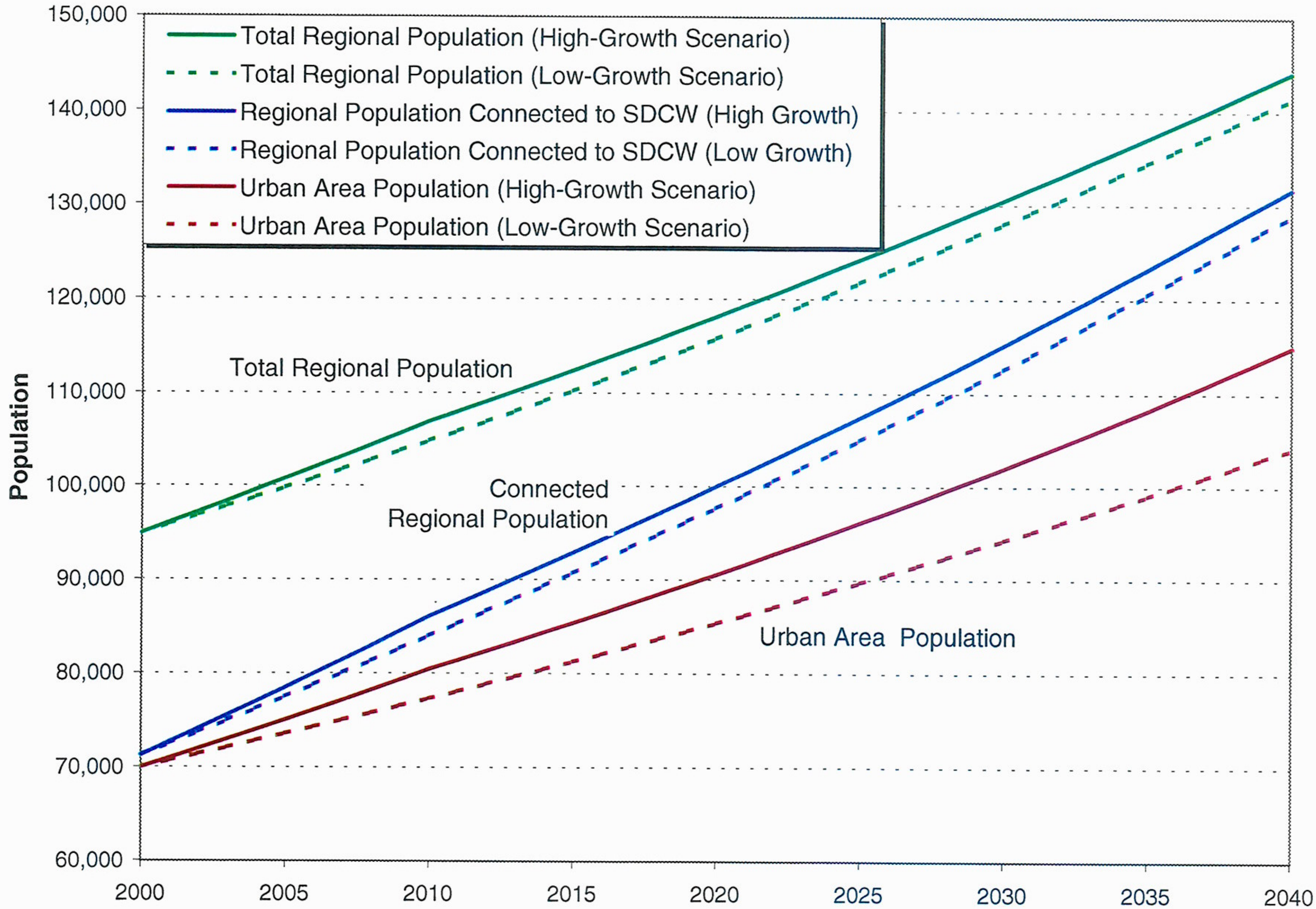

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Figure 3-1
Population Projections

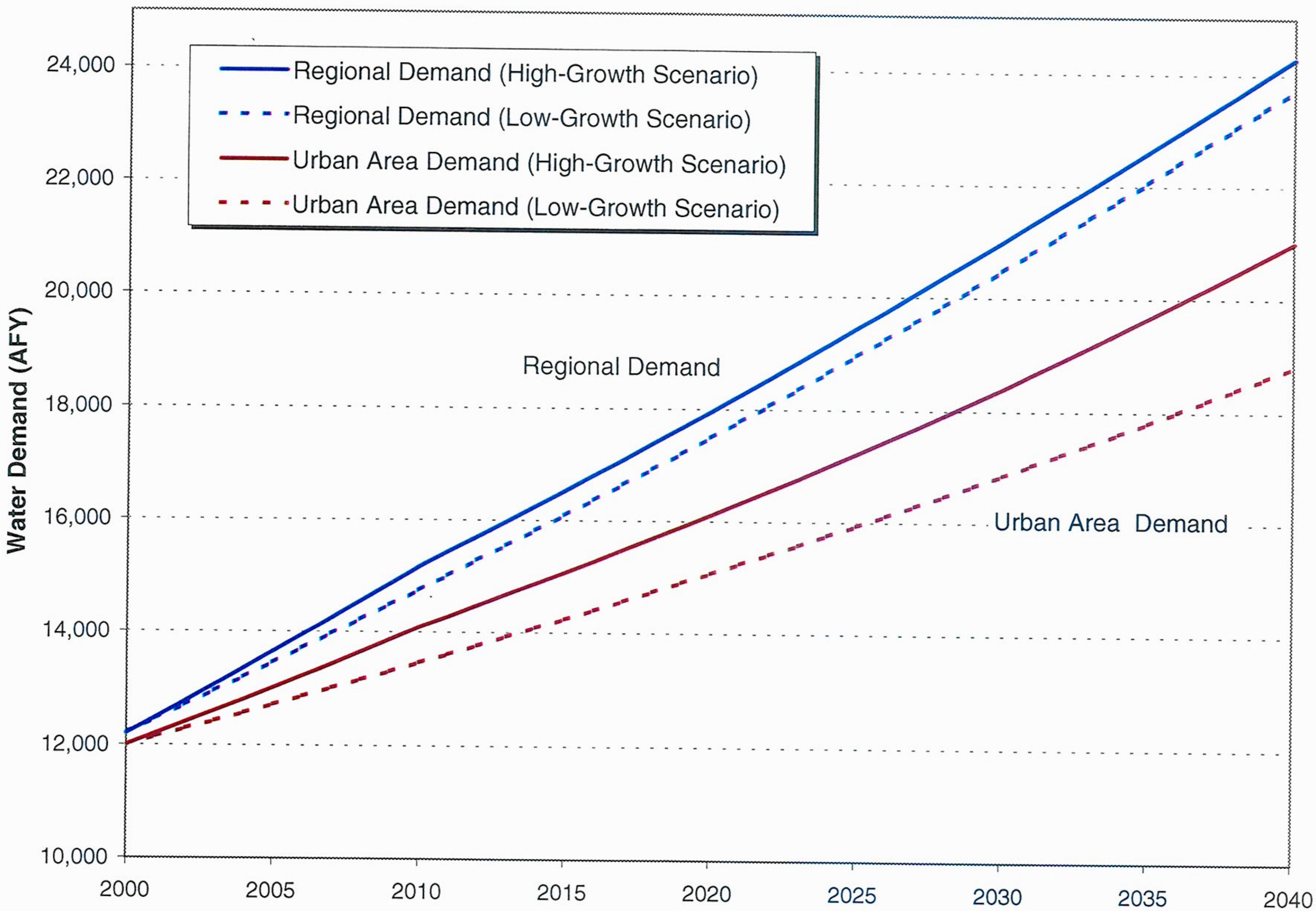

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Figure 3-2
Water Demand Projections

Section 4
Future Water Supply and Resource Management Components

The water resource analysis presented in the preceding sections demonstrates the need to plan for Santa Fe's future water demands. Presently, infrastructure limitations restrict the City's ability to divert, treat, and convey some of its existing water rights holdings. However, even with infrastructure improvements, the City's water rights holdings will not meet Santa Fe's long-term water needs under the current operational structure. Therefore, this Water Supply Analysis evaluates infrastructure improvements as well as options for management of existing water rights holdings as an alternative to the pursuit of additional water development.

The City has taken many actions over the past five years to increase water supply and/or protect the water sources. Since 1995, the City's well field capacity has increased by approximately 1,600 AFY (see Figure 4-1). This has been achieved by constructing treatment systems for the Santa Fe and Alto Street Wells, increasing the depth of the Torreon and Hickox Wells, redrilling the Ferguson and Buckman No. 3 Wells, and drilling the Northwest Well. The City has also completed the Southwest Water Tank, began a process for restoring the Santa Fe Watershed, developed an environmental assessment for the horizontal collector well pilot project, and began a regional water planning process. All of these actions have helped to increase and/or protect the City's water supply.

There is no single solution to the projected differences between water supply and demands in Santa Fe. Rather, a multi-pronged approach to long-term water planning is required. This section describes a number of measures that can be implemented towards meeting the long-term demands, with an emphasis on those measures that can compose or complement the City's emphasis on moving toward a more sustainable water resources portfolio. The benefits and relative costs of each potential component of the future water supply are discussed within each subsection. The components that are ultimately implemented will be those that are the most attractive from an economic and sustainability standpoint. Additional components can be implemented if needed in the future as conditions change or if growth rates are higher than projected.

Because of the large projected shortfall in water supply if no action is taken, as well as year-to-year fluctuations in supply (e.g., surface water variability), multiple components are needed to meet the long-term needs. Moreover, with multiple "tools" available to the City, it can operate its water supply system in the most economical and environmentally responsible mode possible in any given year. Therefore, nearly all of the components of the future water supply are considered potentially feasible.

4.1 No Action

One option available to the City is to indefinitely continue its current water management practices using existing infrastructure, referred to as the "No Action" alternative. This alternative would consist of the following major components:

- Use of Santa Fe Canyon surface water, up to the existing 5,040 AFY water right (including the St. Michael's Well), but often limited to lower amounts by variations in the amount of runoff produced in the watershed.

- Use of the City Wells to provide 4,865 AFY each year (not counting the St. Michael's Well), limited by water rights, existing well capacity, and sustainability of the aquifer.

- Pumping from Buckman, using SJC water to provide the majority of the required offsets (i.e., mainstem Rio Grande). At present offset ratios and with existing infrastructure, this source can supply about 7,000 AFY. This would eventually be limited either by the 5,736 AFY of offsetting Rio Grande water rights (as offset ratios increase and approach 1:1), Rio Tesuque and/or Rio Pojoaque offsetting water rights, or by the sustainable Buckman Well Field yield (estimated at about 5,000 AFY; Boyle 1997).

- Continued use of a small portion of the City's treated wastewater effluent for irrigation-related purposes.

Considering both water rights and infrastructure limitations, the "no action" alternative provides the ability to deliver a maximum of about 12,000 AFY of potable water in wet years to Santa Fe at the present time under average conditions. As shown in Section 3, this quantity falls well short of the projected 2040 Santa Fe area demands. Moreover, the total supply available under the no action alternative will actually drop over time due to the following:

- Continued overdrafting of the local aquifer by the City and other users, lowering the water table and resulting in reduced rates of production from the existing City wells

- Continued pumping of the Buckman Well Field at a rate higher than the 5,000 AFY sustainable limit, lowering the water table

- Increasing Buckman offset ratios, eventually limiting Buckman pumping to as little as 5,736 AFY (at 1:1 offset requirements)

In addition, dry years will further reduce the City's available supply and during these years the City will be unable to meet even current demands (see Figures 2-23, 3-2, and 4-1).

The no action alternative will clearly not meet Santa Fe's long-term projected water demands, and is therefore not considered further. However, establishing baseline conditions under the no action scenario is useful for identifying existing limitations and developing alternatives for meeting Santa Fe's long-term needs.

4.2 Groundwater Well Rehabilitation and Protection

In Section 2.2, it was noted that the wells in the City Well Field are not utilized to their full capacity at the present time due to deficiencies in the wells. The City has begun a program of well rehabilitation to address the deficiencies in the well infrastructure, and water treatment units are now in place on the Alto and Santa Fe Wells, allowing them to contribute to the City's potable system. Together, the completed and planned improvements bring the wells' capacity up to allow full use of the local groundwater right of 4,865 AFY.

However, simply bringing the wells' production capacity up to the City's full water right quantity is not sustainable. Pumping the City Wells at 4,865 AFY would be pumping the local aquifer at a faster rate than it can naturally be replenished (Shomaker 1998). Recharge from precipitation, infiltration of streamflow in the Santa Fe River, and other mechanisms can not keep pace with this rate of withdrawal. Without additional recharge, production from the City Wells would continue to decrease over time, requiring that deeper wells be drilled if they are to continue to produce water.

Rehabilitation of the City Wells can form part of a long-term sustainable water strategy for Santa Fe, provided that increased withdrawals are accompanied by actions taken to increase the rate of recharge. Among the options for enhancing recharge is the use of treated effluent to augment stream flows in the Santa Fe River below the reservoirs. This topic is discussed in more detail later in Section 4.

The City could equip the new Hickox Well with a potential yield of 150 gallons per minute (gpm). This well is neighboring a Brownfield Superfund Site with PCE contamination in the aquifer. Combined with the low yield and potential for water treatment if the well were contaminated, makes this well an expensive proposition with little return.

The City also plans to develop and implement a groundwater protection strategy. By implementing such tools as a wellhead protection program, the City can help ensure that the quality of this vital resource is protected and preserved for long-term potable use.

4.3 Drill Supplemental Wells

The City has a sound management strategy for keeping the production level in the aquifer at a "sustainable" level. The City could explore other locations that tap recharge from the effluent southwest of town that would not interfere with the existing well field.

Buckman Well Field has shown declining capacity since the wells were first drilled in 1972. Buckman Well No. 4 had a yield of over 1,100 gpm as recently as 1992, and in September 2000 the yield had dropped to 270 gpm. The declining yield may be due to encrustation of the well casing. The City is exploring options to clean and reevaluate the pump capacity appropriate for these wells.

There are, however, some issues with this option that would need to be addressed. First of all, increased pumping of the City and Buckman Well Fields will ultimately reduce the capacity of the existing wells. Secondly, additional pumping at Buckman will require retirement of Acequia Water Rights in the Tesuque and Pojoaque Rivers. Lastly, the permitting process necessary to pursue this alternative could be lengthy and take many years to finalize. This well field will have to be managed to maintain the estimated 5,000 AFY through the use of all wells.

4.4 Conservation

Water conservation is a necessary component of overall water management. In addition to supporting the City's water planning process, formal Water Conservation Plans are required for the continued use of water rights and future water rights applications to the New Mexico Office of the State Engineer. The federal government also requires a Water Conservation Plan for all water contracted under a federal program (e.g., SJC water).

Santa Fe has been conservation-minded for many years. This has been shown by the closure of the watershed to the public in 1932 and in previous ordinances and policies. In 1991, the 1978 City ordinances were updated to include uniform building code and city standards such as flow limits for indoor fixtures, restrictions on the amount of irrigated vegetation areas per dwelling unit, and prohibitions on overspray, watering paved or unplanted surfaces, and wasted and fugitive water. SDCW published numerous fliers and brochures and provided other community education services to support conservation efforts.

The City and Santa Fe County prepared the Water Conservation Plan for San Juan Chama Contractors in 1993 in support of their federal contracts for San Juan Chama water deliveries. This document was very general, meeting basic obligations associated with federal water contacts at that time. Federal regulations have expanded, creating a need to produce an in-depth water conservation plan that will support the City's future water rights management, both at the federal and state levels. The City is now preparing a comprehensive Water Conservation Plan, the key components of which are:

- Conservation Ordinance
- Public Education

- Future Programs, including:

    Use of Standard Industrial Classification (SIC) codes to track water use by business category

    Compilation of water production and consumptive use statistics for statistical analysis, for water resources planning, and reporting purposes

    Tracking lost and unaccounted water

    Implementation of a pilot toilet replacement rebate program to convert older toilets to low-flow toilets

    Expansion of the conservation education program

Conservation forms an integral part of Santa Fe's ongoing water management program, as described above. However, during times of water supply shortages, additional demand management measures may be required on a temporary basis to ensure that the basic potable water needs of the community can be met. The effective use of temporary demand management in dry periods was demonstrated during the summers of 1996 and 2000, when low snowpack levels and low runoff in the upper Santa Fe River watershed led to significant water shortages in Santa Fe.

The Conservation Ordinance adopted by the City Council in 1996 includes provisions for day-to-day conservation plus mandatory demand reduction in times of water shortages. Ordinary conservation includes indoor and outdoor measures, as well as water rate structures geared toward encouraging conservation. Surcharges are increased and penalties can be assessed for high water use during drought conditions.

The City's ongoing conservation program encourages conservation at moderate levels. This provides the ability to implement short-term, more stringent measures to reduce consumption during times of low water supply. By maintaining the ability to temporarily reduce consumption via enhanced conservation, the City has a built-in "safety factor" in its ability to provide water in times of drought or other water shortage.

4.5 Conjunctive Use of Local Supplies

Surface water runoff in the upper Santa Fe River watershed is highly variable from year to year, depending on levels of precipitation and snowpack and other meteorological factors. Thus, although the City holds water rights of about 5,000 AFY on this source of supply, the actual runoff produced in the watershed is much lower in some years. Other years, the watershed produces more than the City's water rights holdings. If the City has storage capacity available in its reservoirs and no calls are made on this water, the City may store the excess water for future use, provided that the permitted storage limit in the two reservoirs (4,000 AF) is never exceeded.

The majority of any water that is released (reservoir spills, releases, etc.) is expected to seep through the downstream river bed and infiltrate into the aquifer, such that stream flow usually ceases before reaching the City's WWTP discharge downstream. Recognizing the interconnection of these water resources, the City plans to pursue authorization for conjunctive use of its Santa Fe River and City well water rights with the Office of the State Engineer.

The City would prefer to use its available surface water supplies to meet the baseline demand to the extent possible, preserving the use of groundwater for periods of high demand and maximizing the useful life of that source of supply. Under a conjunctive use agreement, the City would be authorized to use all available surface water in the upper Santa Fe River watershed, provided the total local water use (surface and groundwater) did not exceed its combined local surface and groundwater rights of 9,905 AFY. The City would also like to pull its minor rights (e.g., Osage, Acres Estates, and Country Club Estates Wells) into a combined right that could be conjunctively used with its surface water rights. This will require, at a minimum, state approval and revision of the Rio Grande Compact.

Thus, in wet years, the City would divert more from the Santa Fe River than its approximately 5,000 AFY of surface water rights, but would use less groundwater. Decreased groundwater use would allow greater recharge of the aquifer from precipitation during wet years. Because streamflow is rarely continuous through town, even during reservoir spill events, the City's increased use of surface water from the upper Santa Fe River watershed will not significantly affect water quantities downstream of the WWTP, where other uses of Santa Fe River water exist. It would, however, intercept water that would have seeped from the riverbed and recharge the aquifer.

An examination of historic flows in the upper Santa Fe River watershed (1914-1997) suggests that the yield of the river is greater than the 5,040 AFY of surface rights in nearly one out of every 2 water years. With conjunctive use, if the City were allowed to utilize all available surface water up to its conjunctive right of 9,905 AFY, the City would withdraw an additional zero to 4,865 AFY from the river, averaging about 1,400 AFY over the long term. This would directly enhance the sustainability of the City Well Field. Withdrawal of more than about 9,000 AFY of surface water may require upgrades to the Canyon Road WTP, which was designed for an average flow of 8 mgd (which converts to an annualized rate of about 9,000 AFY).

Conversely, in dry years (e.g., surface runoff of less than 5,000 AFY in the upper Santa Fe River watershed), the City would increase its rate of groundwater use while diverting all available surface water from the watershed. The City's total conjunctive use from these two sources would still be limited by the total local water right of 9,905 AFY. Increased use of groundwater during dry years would likely require well infrastructure upgrades or additions. Even with recent and planned upgrades, the City Wells will be unable to produce the full 9,905 AFY. Thus, the use of at least some surface water would be required every year to fully use the conjunctive rights, regardless of runoff quantities.

4.6 Augmentation of Water Supplies with Treated Effluent

The City's long-term strategy for treated wastewater management is outlined in its TEMP (CDM 1998). The two largest effluent use applications identified in the TEMP are integral to water resource augmentation. In this way, treated effluent is a key component of the City's Water Plan. The TEMP focused on treated effluent use; the City's plans for management of its treated effluent have since been developed into a more comprehensive effluent use and river restoration plan, the Santa Fe Water Management and River Restoration Strategy (WMRRS).

4.6.1 City Well Recharge

The WMRRS calls for a portion of the City's treated effluent to be pumped to the upper Santa Fe River below the reservoirs, near the site of the former Two Mile Dam. The first reservoir, Two Mile, was constructed upstream of town in the late 1800s. Later, McClure and Nichols Reservoirs were added in 1926 and 1943, respectively. Two Mile Dam was eventually breached due to concerns over its structural integrity.

The presence of these reservoirs on the upper Santa Fe River has altered flow patterns on the river as it travels through town, primarily now consisting of intermittent flows in response to storm events and infrequent spilling from Nichols Reservoir. Although flow in the river before the reservoirs were constructed was also likely intermittent in nature, the overall frequency of flow was certainly higher without the City's diversion of water for potable use. More frequent flows would be expected to increase recharge to the aquifer via infiltration through the streambed. A number of studies have analyzed the rate at which water in the river infiltrates through the streambed. A summary of data was provided in the TEMP, showing an average loss to groundwater of about 0.5 to 0.75 cfs per mile of stream length in the reach between the reservoirs and the WWTP (when the river is flowing). A recent seepage study by the City in September 1999 (Lewis 2000) showed an initial seepage loss of about 0.7 cfs/mile in the reach between St. Francis and Frenchy's Field, but this rate decreased to 0.3 cfs/mile after 4 days.

By pumping treated effluent to the upper Santa Fe River, the City can augment stream flows and thereby increase the rate of recharge to the aquifer. This would benefit the City and the community as a whole by partially offsetting the impacts of groundwater withdrawals, leading towards a more sustainable use of the groundwater resource. Other benefits of this application of treated effluent include the habitat, aesthetic, and possible recreational benefits of a flowing river through town. Possible negative aspects include the presence of wastewater constituents that are not fully removed by the WWTP process.

Under current New Mexico State Engineer policies, it is not clear if the City would gain a water rights credit or benefit from Santa Fe River stream augmentation and aquifer recharge. Once effluent is released to a surface water of the state (such as the Santa Fe River), it is no longer considered "private water" and cannot be used to gain credits. The City will explore the possibility of obtaining return flow credits under this scenario. Increased withdrawals of the commingled effluent and native groundwater would be limited to quantities already permitted. Past efforts by the City to increase its permitted rights have been unsuccessful. Releasing the water to the upper Santa Fe River is integral to the proposed recharge application. Alternatives, such as direct injection of effluent, are significantly more expensive to implement and operate, and do not have the tangential benefits associated with streamflow augmentation.

Nevertheless, the City recognizes the value to the City and all other aquifer users in increasing the sustainability of the aquifer. Ultimately, if aquifer withdrawals continue at existing or increased levels and recharge rates are unchanged, water table levels will continue to drop in the vicinity of the City Wells. This would force the City and other users to either drill deeper to continue use of the groundwater, or seek alternate sources of supply to replace the groundwater resource. Either option has significant costs and other negative aspects associated with it.

Historically, the City saw an average of 40 percent to 50 percent of its potable water demand returned to the WWTP as wastewater. Today, a return rate of 60 percent is more common. The difference can be attributed to Santa Fe's shift toward a more urban environment (instead of outdoor use, with high irrigation demands), and increased sewerage. The City may petition the SEO to obtain this increment for reuse or return flow credit.

The WMRRS will be phased in over a period of time as effluent supplies grow and planning studies and design are completed. The City is considering construction of the required pipeline from the WWTP to the upper Santa Fe River discharge point such that flow augmentation could begin between 2005 and 2010.

4.6.2 Return Flow to Rio Grande

The TEMP and WMRRS include plans to return treated effluent to the Rio Grande. As described in Section 2.2.6, returning flow to the Rio Grande could allow the City to divert much more water than its current SJC contract amount of 5,605 AFY. With a one-for-one credit for treated effluent of "imported" origin returned to the Rio Grande, the City could divert as much as 14,000 AFY without additional water rights or contract holdings. The amount of water that can be diverted under the existing contract holding is limited by the fraction of water that is consumed (i.e., not returned to the WWTP as raw wastewater). At historical consumption levels of about 40 percent of potable water, a diversion of 14,000 AFY of water from the Rio Grande would result in the return of around 8,400 AFY to the WWTP. Returning this "imported effluent" to the Rio Grande, together with the 5,736 AFY consumptive quantity, would allow continued diversion of about 14,000 AFY.

In the TEMP, water supply and demand projections were used to estimate the potential "demand" for return flow credits to the Rio Grande between 2000 and 2020. Without return flow credits, the TEMP estimated that a present value capital outlay of $27M (1998 dollars) would be required to purchase imported water rights from the Rio Grande basin over this time period. In contrast, the cost for construction of both a pipeline to the Rio Grande near Buckman and the pipeline to the upper Santa Fe River would be approximately $24M (present value, 1998 dollars), with no water rights purchases required in this time frame. To meet the return flow credit "demand," the TEMP estimated that the pipeline to the Rio Grande would need to be constructed by about 2005.

In this way, returning flow to the Rio Grande can help augment the City's water resources without requiring the purchase or contracting of additional water rights for the foreseeable future. However, with water rights needs alleviated, the City does not have the infrastructure required to divert and deliver the additional water to its customers in town. The Buckman Well Field's sustainable yield has been estimated at about 5,000 AFY (Boyle 1997), about 900 AFY of which is supplied to Las Campanas. Adding wells at Buckman is not considered to be an effective option, since significant impacts on existing wells' production would be anticipated. Thus, as would be the case with any increased use of imported water, new diversion, treatment (type and degree dependent on water quality), and conveyance infrastructure will be required to actually use the increased diversion quantity associated with return flow of treated effluent.

An alternative to using treated effluent to gain return flow credits would be the use of treated effluent to help satisfy the Buckman offset requirements. This option is discussed later in this section.

4.6.3 Public and Private Partnerships

The City has in the past provided treated effluent for use as irrigation water to users in the vicinity of the WWTP. Using effluent for purposes such as irrigating turf has the effect of replacing an existing (or future) demand on the City's drinking water. In turn, this will reduce the City's need to use expensive imported water. Reduced importation of water would not only save investment in production and transmission facilities and in pumping costs, but it would reduce the need to obtain the water rights, which are required to support water importation. It is clearly and directly beneficial for the City to reduce its need for expensive, additional water supplies by using effluent to replace drinking water that is now (or will be) used for purposes such as turf irrigation. The TEMP includes a plan for the continued use of a portion of Santa Fe's treated effluent for irrigation and other nonpotable uses.

The City's existing water wheeling agreements with the Las Campanas development were described in Section 2. Las Campanas uses the City's infrastructure to deliver Las Campanas' water rights from the Rio Grande to the development's system. Las Campanas has the necessary treatment and conveyance systems in place to reuse its own treated effluent for irrigation on its golf courses and other areas. However, the low density of the development and partial-year occupancy of many of its residences produces insufficient effluent to supply its irrigation demands. As such, Las Campanas has in the past indicated an interest in the potential use of City effluent to meet its irrigation needs. Agreements with Las Campanas or any other private entity may have the potential to benefit the City, but must be evaluated on a case-by-case basis and in the context of impacts on receiving return flow credits.

4.7 Management of Imported Water

Santa Fe has permits and contract rights to significant quantities of imported water to help meet its potable water demands, including the Buckman permit and the SJC contract water. Management of these water resources must be carefully planned and implemented to make the best use of the available water, thereby minimizing or delaying the need for additional imported water supplies and the associated high costs of obtaining additional water rights or agreements.

4.7.1 Buckman Offsets

As described in Section 2.2.3, use of the City's Buckman Well Field permit requires that impacts to the Rio Grande and Rios Tesuque and Pojoaque be offset with other water rights. The amount of impact to the Rio Grande is calculated annually by the State Engineer. Eventually, the impact will reach one-to-one, meaning that for each acre-foot of water pumped from Buckman, the City will need to replenish 1 acre-foot of flow with offsetting water rights. Presently, the only significant source of offsetting Rio Grande water available to the City is its SJC contract water, which is released from upstream reservoirs on the Rio Grande to offset Buckman withdrawals according to the State Engineer's model calculations. However, if treated effluent is conveyed back to the Rio Grande, the treated effluent could instead be used for satisfying at least a portion of the Buckman offset requirements.

To satisfy the full offset requirements (as the required offset ratio approaches 1:1, and assuming a maximum sustainable yield of 5,000 AFY from the Buckman Well Field) would require the return of 5,000 AFY of "imported effluent" (i.e., about 4.5 mgd of effluent flow from the WWTP). At a 40 percent consumptive rate, this relates back to diversions of at least 8,300 AFY of raw imported water (e.g., 5,000 AFY from Buckman, and 3,300 AFY from other diversions). Use of treated effluent for Buckman offsets would in turn free up some or all of the SJC water for direct diversion and consumptive use by the City.

Alternatively, the SJC water could continue to be used to provide the required Buckman offsets. Under this scenario, treated effluent returned to the Rio Grande would be used for return flow credits. However, once the offsetting requirement ratio reaches one-to-one, the City's 5,605 AFY of SJC water will allow only 5,605 AFY of Buckman withdrawals, well short of the 10,000 AFY permitted amount.

The use of return flow for diversion credits versus for Buckman offsets differs primarily in terms of water "accounting." Returning treated effluent to the Rio Grande would be required in either case, as would new diversion infrastructure. The City's pilot diversion project using a horizontal collection well along the banks of the Rio Grande on the San Ildefonso Pueblo is currently underway, with hydrologic and water quality results anticipated in mid to late 2000.

Thus, Santa Fe has the potential for future flexibility in how it satisfies the Rio Grande offset requirements for pumping from the Buckman Well Field. Independent of the method of water accounting used, return of treated effluent to the Rio Grande is key to the City's long-term management of imported water.

4.7.2 San Juan-Chama Diversion

The City's SJC pilot diversion project is underway, as described in Section 2.6. Regardless of whether treated effluent is used for return flow credits or for Buckman offsets (and whether SJC water is used for direct diversion or Buckman offsets), the City does not have adequate infrastructure. New or additional infrastructure is required to divert the additional imported water from the Rio Grande, treat it (to the degree necessary, depending on raw water quality), and convey it to its potable water customers.

The pilot diversion will evaluate whether horizontal collection wells at the selected location (on San Ildefonso Pueblo land adjacent to the Rio Grande) are suitable for diverting the additional water, independent of the method of "accounting" (i.e., return flow versus direct SJC use) used in determining water supply quantity and sources. If the pilot shows unfavorable water supply or water quality results, other options such as a direct surface diversion or other indirect diversion technologies will be evaluated by the City and implemented as appropriate. A parallel study will be used to evaluate the feasibility of diversions at other sites.

4.8 Restrictions on Domestic Wells in the Service Area

The widespread use of individual domestic wells in the area strains Santa Fe's groundwater resources, and undermines the sustainable water management objective. Santa Fe's goal is for all new growth within the greater Santa Fe area to be served by the municipal potable water system. As an example, a goal may be to connect users who are presently on wells and/or out of the service area to the water system and to connect up to 50 percent of the population of the proposed urban area now served by domestic wells. Santa Fe will also strive to maximize the connection of its water customers to sanitary sewers in order to reclaim the water as treated wastewater effluent. In support of this effort, the Santa Fe City Council has adopted an ordinance restricting domestic wells in the SDCW service area.

4.9 Watershed Restoration and Water Yield Improvements

Current conditions of the Santa Fe River watershed ecosystem, created by 100 years of fire suppression, pose a substantial threat to the surface water supply that could result in catastrophic fire, flooding, and loss of this water supply without extensive restoration efforts. The primary problem in the watershed is the high density of trees. The high density of trees:

- Creates a great risk for catastrophic fire
- Caused a loss of water yield (30 percent) from the watershed
- Reduced ground cover (because sunlight is restricted), resulting in soil loss and no food source for many native fauna
- Stunted growth of trees, so very few are big (small trees are more likely to die in a fire and are more susceptible to disease)

The Upper Santa Fe Watershed consists of 17,200 acres of forest. Organized fire suppression began in the watershed in the early 1900s. Fire exclusion over the past century has resulted in an increase in tree numbers, fuel accumulations, and a decrease in water-retaining ground cover and water yields. The increase in fuel and trees creates the potential for catastrophic wildfires and severe watershed damage.

In 1932, the watershed was closed to public access by order of the Secretary of Agriculture, due to overuse. Photographs from that period reveal devegetated slopes above the reservoirs, a result of grazing and fuelwood gathering. The closure has allowed the watershed to recover to a great extent; however, the suppression of all fires and absence of active management has resulted in the problems described above.

Catastrophe has occurred in other communities. The Buffalo Creek Watershed that feeds part of the City of Denver's water supply was in a similar condition to the Santa Fe Watershed. A fire started by boy scouts caused a high intensity fire which burned not only the trees, but also all the grass and roots holding the soil in place. A few days later heavy rains resulted in flooding, which destroyed two towns and clogged the cities' water intake with propane tanks, cars, and silt and they were unable to treat the water. Now they are spending many millions of dollars to reclaim the forest that lost in 1 year, the amount of topsoil that was expected in 20 years.

Such catastrophes can be avoided by reducing the fuel loading, and watershed benefits can be expected as a result. The City of Santa Fe has been working collaboratively with the USFS and environmental groups in the Santa Fe area to develop a treatment plan for reducing the density of fuels, and is embarking on a program to restore the watershed toward natural conditions.

The treatments in the Santa Fe Watershed presently being proposed by the City, if implemented, will be monitored for impacts to soil erosion, turbidity, stream flow, vegetation, wildlife, stream morphology, and macroinvertebrates.

4.10 Pursuit of Additional Imported Water

In developing its water plan efforts, the City has emphasized the use of sustainable practices where practical and cost-effective. Properly managed, and with the necessary infrastructure in place, the City's existing water rights and agreements can be used to satisfy its needs throughout the plan period. The pursuit of additional imported rights, as would be necessary to meet projected demands if the actions outlined in this plan were not undertaken, was not considered a viable option because of the desire to shift towards sustainable practices and the following:

- The purchase of additional imported water rights, such as native Rio Grande rights, would be very expensive
- The possibility exists that sufficient additional water rights may not be available, now or in the future, to meet the long-term demands in Santa Fe
- Santa Fe recognizes the value in collaborating, not competing, with its neighbors in northern New Mexico for the extremely precious water supplies in the area

4.11 Summary of Water Supply Components

To satisfy Santa Fe's projected water demands over the next 40 years requires a multi-pronged approach, since there is no single action that will satisfy the complex needs and mesh with the existing water rights and infrastructure. The use of multiple supplies and sustainable practices allows the City to select the most cost-effective and beneficial water resources strategies as part of an ongoing optimization, and prevents the reliability issues associated with a single source of supply.

Based on the analyses presented in the preceding sections, supply options under the City's water resources plan could include the following:

- Rehabilitate Buckman Well Field
- Continued use of local surface water and groundwater resources, as modified by items below
- Conjunctive use of local surface water and groundwater rights, subject to approval by the New Mexico State Engineer
- Rehabilitation of the City Wells to support the use of the City's full existing groundwater right, and implementation of a groundwater protection program
- Restriction of new domestic wells in the vicinity of the water service area, and maximizing connection of potable water customers to sewers to allow reuse of that water
- Continuation and expansion of the City's conservation program, with additional temporary demand management measures in times of water shortages

- Returning treated wastewater effluent to the Rio Grande for use in attaining return flow credits, as Buckman offsets, or both
- Continued use of SJC water as a source of imported water, either for use in attaining Buckman offsets or as direct diversions from the Rio Grande, and renewal of the SJC contract upon its expiration in 2016
- New infrastructure to divert, treat, and convey additional imported water to the City's potable water customers, independent of the source of supply (SJC water, Buckman, or return flow credits from treated effluent)
- Watershed restoration and water yield improvements

The City could consider several water supply scenarios to assess the impacts of key components of the City's current or potential future water resources portfolio. Key constraints considered for each scenario are described below.

For the scenarios under which conjunctive use rights for local water <u>are not</u> in place:

- City Wells are limited by water rights to 4,865 AFY.
- Santa Fe River and St. Michael's Well combined right is 5,040 AFY.
- Santa Fe River yield is 3,550 AFY in planning scenario (per Section 2.3.4).
- St. Michael's Well capacity is 700 AFY.
- Return flow credits, if any, are limited to 60 percent of the combined diversion of water at Buckman and/or via a direct diversion.
- The City must have adequate imported water rights to support its use of direct diversion water from the Rio Grande (not necessarily native Rio Grande water) and Buckman withdrawals, factoring in the Buckman offset ratio. With existing water rights and sustainable pumping of Buckman at 5,000 AFY, this limits the direct diversion quantity to a maximum of about 10,900 AFY.
- A goal of having supplies available to meet 120 percent of the projected annual urban area demand in any given year might be used as a target supply quantity.
- Sustainable withdrawal rates, as defined earlier in this document, may be used where possible (3,725 AFY for City Wells plus St. Michael's Well; 5,000 AFY for Buckman).

For the scenarios under which conjunctive use rights for local water are in place:

- The conjunctive local rights limit total withdrawals from the City Wells, Santa Fe River, and St. Michael's Well to 9,905 AFY.

- The Santa Fe River yield is 3,550 AFY in planning scenario (dry) years (per Section 2.3.4); during such years, additional City Well withdrawals can be made. For the wet year scenarios, the long-term average yield in the Santa Fe River is 6,440 AFY, and City Well withdrawals would be reduced accordingly.

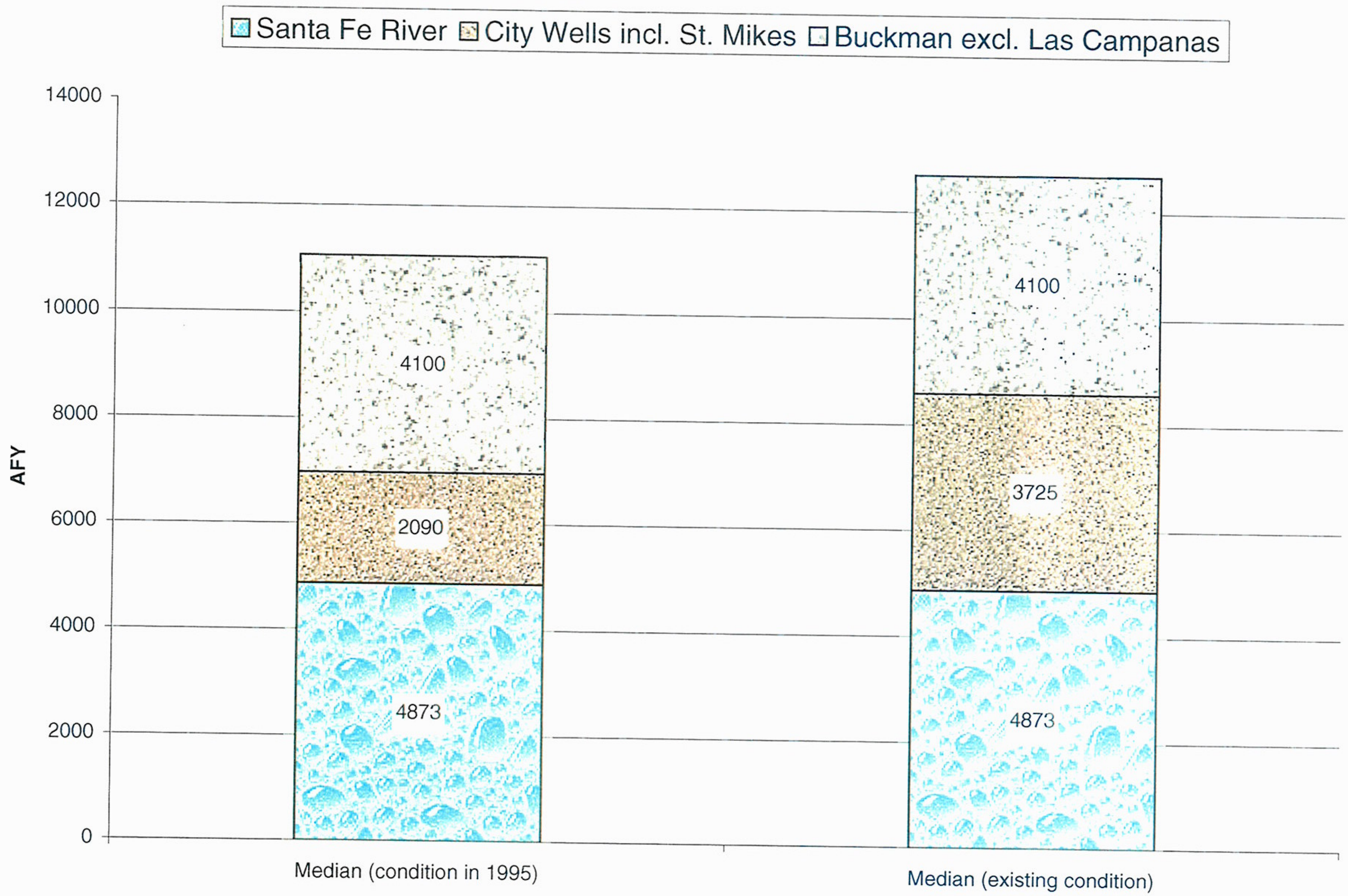
- St. Michael's Well capacity is 700 AFY.

- Return flow credits, if any, are limited to 60 percent of the combined diversion of water at Buckman and/or via a direct diversion.

- The City must have adequate imported water rights to support its use of direct diversion water from the Rio Grande (not necessarily native Rio Grande water) and Buckman withdrawals, factoring in the Buckman offset ratio. With existing water rights and sustainable pumping of Buckman at 5,000 AFY, this limits the direct diversion quantity to a maximum of about 10,900 AFY.

- A goal of having supplies available to meet 120 percent of the projected annual urban area demand in any given year might be used as a target supply quantity.

- Sustainable withdrawal rates, as defined earlier in this document, may be used where possible (3,725 AFY for City Wells plus St. Michael's Well; 5,000 AFY for Buckman).



CDM Camp Dresser & McKee Inc.
SDCW Diversions Historical.xls: Fig 4-1 1/10/2001

Figure 4-1
Current and Past Capacity of Sangre de Cristo Water

Appendix A
References

Appendix A
References

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Appendix B
Reservoir Storage Model Description

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Reservoir Storage Model

Reservoir Storage Model Description

The model uses simple level-pool routing algorithms for both reservoirs. In other words, it assumes a level (rather than sloped) reservoir pool water surface for all elevation-dependent calculations (i.e., spills and evaporative losses). The fundamental mass balance equation for the model is the following:

$$dS/dt = \text{inflow} - \text{release} - \text{spill} - \text{evap/precip} \qquad (1)$$

where:

S	=	Reservoir storage
inflow	=	Total inflow to reservoir
release	=	Controlled release from reservoir
spill	=	Uncontrolled discharge to spillway
evap/precip	=	The net loss or gain to the reservoir due to the combined effects of evaporation and direct precipitation

Equation (1) is solved using a finite-difference approximation leading to an iterative numerical solution of the following equation (for S(i)):

$$\Delta t(\text{inflow}(i) - \text{release}(i) - \text{spill}(i) - \text{evap}(i)) + S(i\text{-}1) - S(i) = 0 \qquad (2)$$

This equation is non-linear and requires an iterative solution at each timestep due to the fact that both spill(i) and evap(i) are dependent on the value of S(i), as described below. For McClure Reservoir, inflow and release are input as a time series of known values, while S(i-1) is the storage solved for at the previous timestep. The evap variable is solved for using an input net rate (depth/time) and multiplying this by the approximate average reservoir surface area for the current timestep. This surface area is approximated using the average storage for the given timestep and linear interpolation of an area-storage table for McClure. The reservoir spill is also calculated using the average storage for the given timestep and linear interpolation of an elevation-storage table and then a spill-elevation table. For Nichols Reservoir, the variable values are assigned in a similar way, except that the reservoir inflow is set equal to the release plus spill values from McClure.

Equation (2) is solved for S(i) using an iterative root-finding method, know as the "Bisection Method." This method uses high and low initial guesses of S(i) and narrows in on the actual value that satisfies Equation (2) by continually bisecting the high and low range in the appropriate manner until a specified convergence criteria is reached.

The area-storage, elevation-storage, and spill-elevation tables mentioned above are interpolated at each iteration using a simple linear approach. The three tables are user-input for each reservoir at any level of detail. The model takes the given independent variable (i.e., storage or elevation) and finds the location of the current value in the table. It then linearly interpolates between the two closest bracketing table entries to estimate a corresponding dependent variable value.

The model is written in modular, easily-modified Microsoft *Visual Basic Code* for *Excel* with *Excel* input and output data worksheets and graphs.

Running the Model

The user must input a time series of Santa Fe River upstream flows (into McClure), McClure controlled releases, Nichols controlled releases (as both WTP demands and Acequia/Santa Fe releases), and net evaporation/precipitation rates. The total time period of interest, timestep, and initial storage values (for both reservoirs) must also be input. The model is well-suited for daily timesteps, particularly since most of the available flow and storage data are given as daily averages. Larger timesteps can be used but at the cost of less resolution and accuracy in the model predictions. Smaller timesteps will probably not result in significant increases in accuracy (as reservoir fluctuations are generally large timestep processes) and computing time can be greatly increased.

Once all of the input has been entered in the "input" worksheet, the model can be run through "tools"-> "macro"-> "reservoirs." Alternatively, the program can be run from within *Excel's Visual Basic* Editor.

Appendix C
Water Rights and Well Data

Water Rights

Table C-1. Local Water Rights

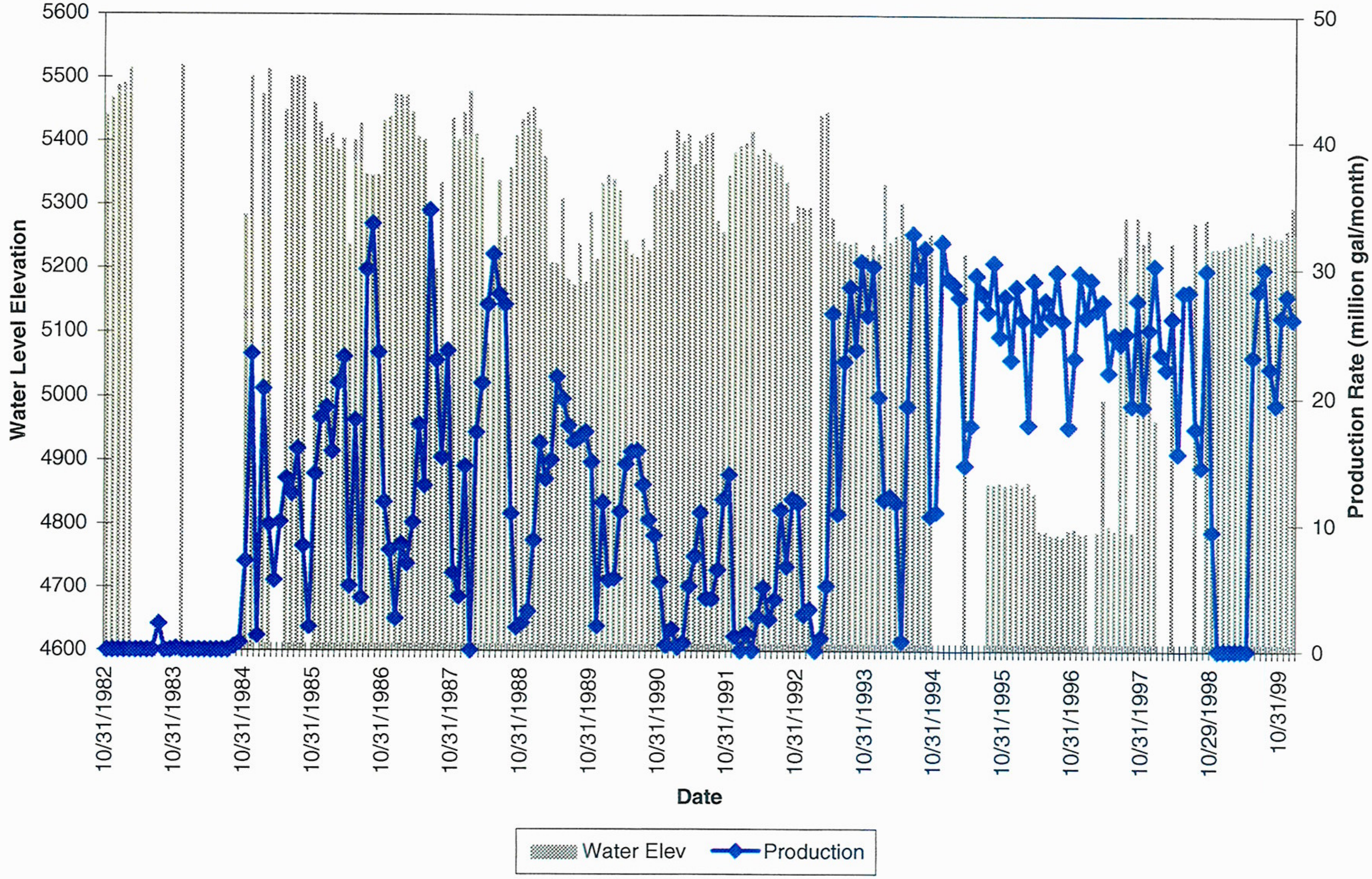
Name	SEO File Number	Priority	Diversion Amount Acre-feet	Consumptive Right Acre-feet	Stream	Date of Ownership	Location
Santa Fe River	Declaration 01278	1880	1540		Santa Fe River		
Santa Fe River	Amendment to Dec 01278		2961		Santa Fe River		
Santa Fe River	License 1677 & RG-304	1925	3500		Santa Fe River		Upper Canyon Road
Acequia del Llano	none		0.54		Santa Fe River		Talaya Hill Grant
Acequia Madre	none		12.15		Santa Fe River		4.5 acres of Patrick Smith Pk
Arroyo Hondo/Pino	Declaration 01617	< 1900	10.59	7.2+3.0	Arroyo Hondo		T 16N R 8E Sect 33 and 28
City wells	RG-1113-1118	1946-51	4865				
Agua Fria	RG-1118						T17N.R9E 27.232
Alto	RG-1113						T17N.R9E 23.3322
Ferguson	RG-1116						T17N.R9E 23.3233
Hickox	RG-1114					1946	T17N.R9E 26.222
Northwest Well	RG-68302-Expl						T17N.R9E 10
Santa Fe (Baca St.)	RG-1117						T17N.R9E 26.133
Torreon	RG-1115						T17N.R9E 22.441
St. Michael's Well	RG-304	1958	1600**		Santa Fe River		T17N.R9E 34.4222
Osage Well	RG-304-S	1948	25.06				T17N.R9E 27.3141
Country Club Estates Well	RG-24042	1739 &1975	22.26				T16N.R8E 12.1444
Acres Estates Wells	RG-3767 & 3767-S	1947	54.62				T16N.R9E 6&7,T16N.R8E1&12
Hagerman Well	RG-590		233.1	116.55		Not yet?	
Sol y Lomas	RG-23884 & RG-23884-S	1947?	50			1974	T16N.R9E.1.334

Table C-2. Imported Water Rights

Name	Permit/ Subfile No. (map.track)	Priority	Diversion Amount Acre-feet	Consumptive Right Acre-feet	Acequia	Stream	Location
Offset Rights	Aamodt 28.29		51.99	25.995	Acequia Madre	Tesuque	Tract 29, Sheet No. 28
	Aamodt 28.31		0.12	0.06	Acequia del Medio	Tesuque	Tract 31, Sheet No. 28
	Aamodt 28.30		0.88	0.44	Acequia Madre	Tesuque	Tract 30, Sheet No. 28
	Aamodt 28.28		3	1.5	Acequia Madre	Tesuque	Tract 28, Sheet No. 28
	Aamodt 28.28		6	3	Acequia Madre	Tesuque	Tract 28, Sheet No. 28
	Aamodt 9.7		62.88	31.44	Acequia La Nueva	Pojoaque-Nambe	Tract 7, Sheet No. 30
	Aamodt 30.1		19.08	9.54	South Rancho Viejo Ditch	Rio Capulin/Pojoaque	T19N R10E 25
	Aamodt 30.3&30.5		1.38	0.69	North Rancho Viejo Ditch	Rio Capulin/Pojoaque	T19N R10E 25
	Aamodt 19.18		3.063	1.532	Acequia Barranca Blanco	Pojoaque-Nambe	Tract No 18, Sheet No 19
	Aamodt 4.47		3	1.5	Acequia de la Otra Vanda	Pojoaque-Nambe	Tract No. 47, Sheet No 4
	Aamodt 19.18		9.87	4.94	Acequia Barranco Blance	N-P River System	T19N R9E 7
Total Offset Rights			**161.3**	**80.6**			
San Juan-Chama				5605		San Juan-Chama	
			7.92		Acequia de la comunidad		
Buckman Permit	RG-20516, et al	1976	10000			Rio Grande and Trib.	
Buckman 1							T19N.R7E 36.31
Buckman 2							T19N.R7E 36.43
Buckman 3							T18N.R7E 1.21
Buckman 4							T18N.R7E 1.23
Buckman 5							T18N.R7E 1.43
Buckman 6							T18N.R7E 1.44
Buckman 7							T19N.R7E 36.23
Buckman 8							T19N R7E 35.31
Valley Utility Water Rights	RG-6651 & 6651-S	1956	226.34	113.17			
Valley Utility Water Rights	RG-6651 et al. into	1956	35.44	17.72			

Historical Well Levels and Pumping Data

Water Level and Production Data
Buckman Well 1



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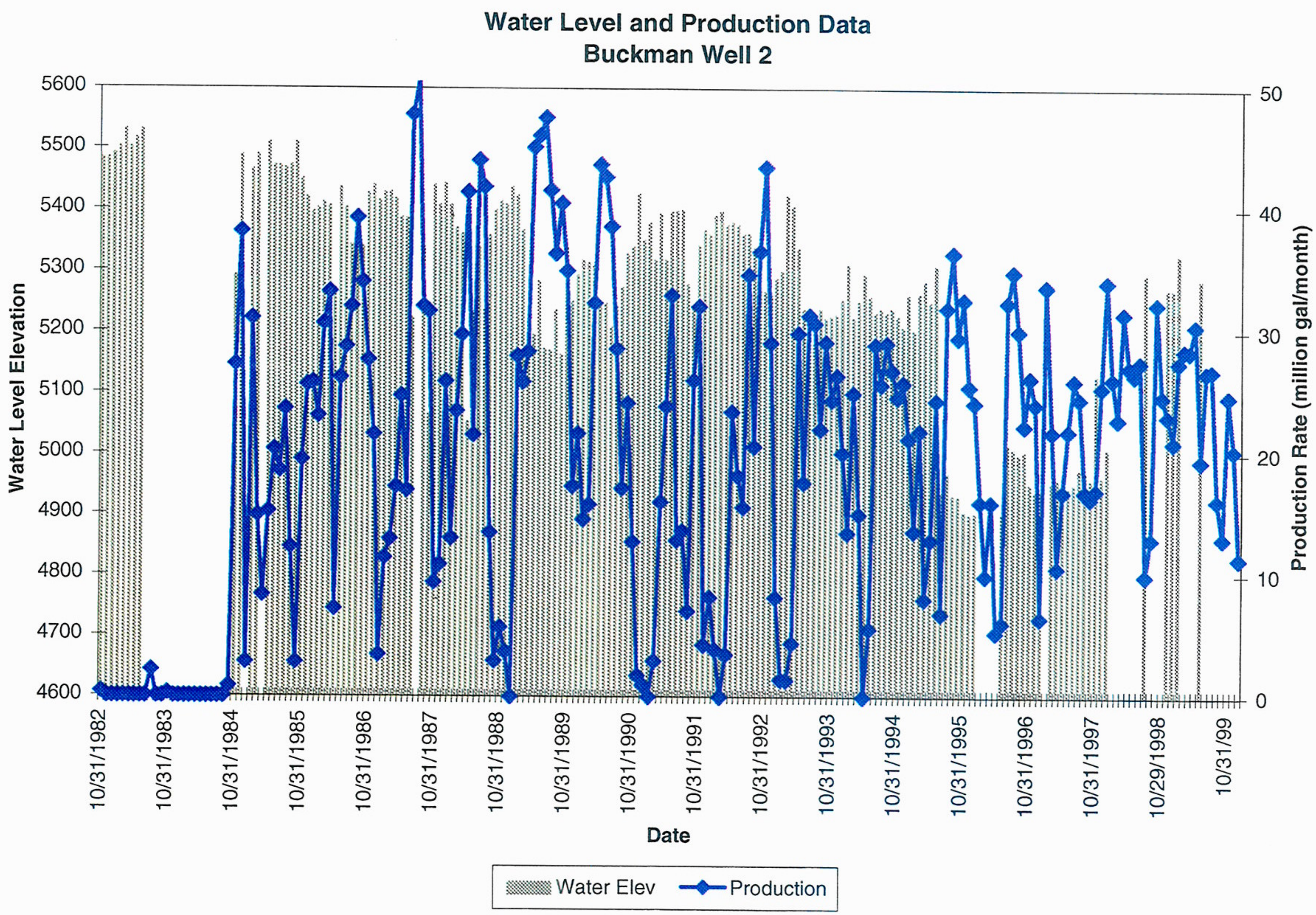

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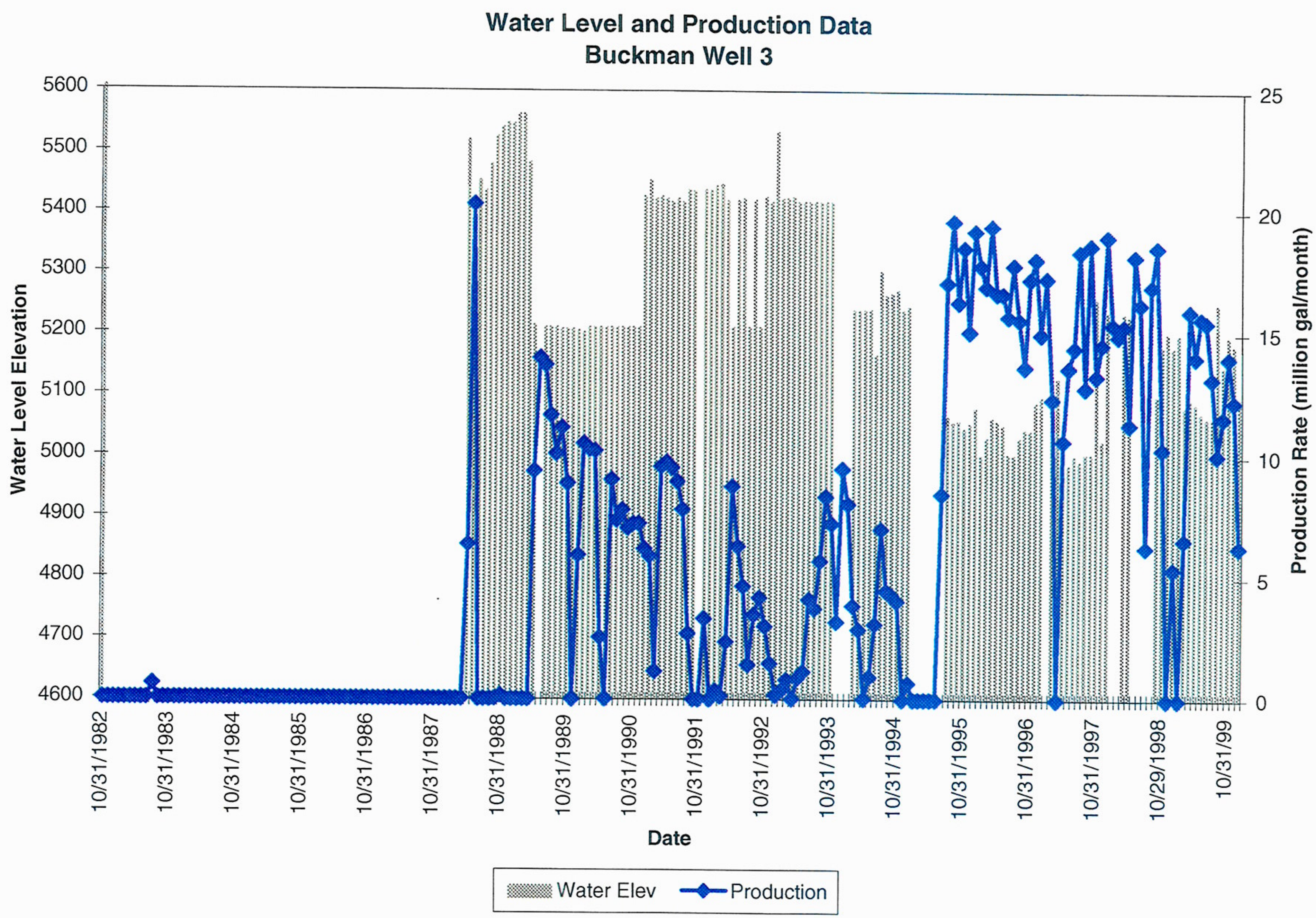

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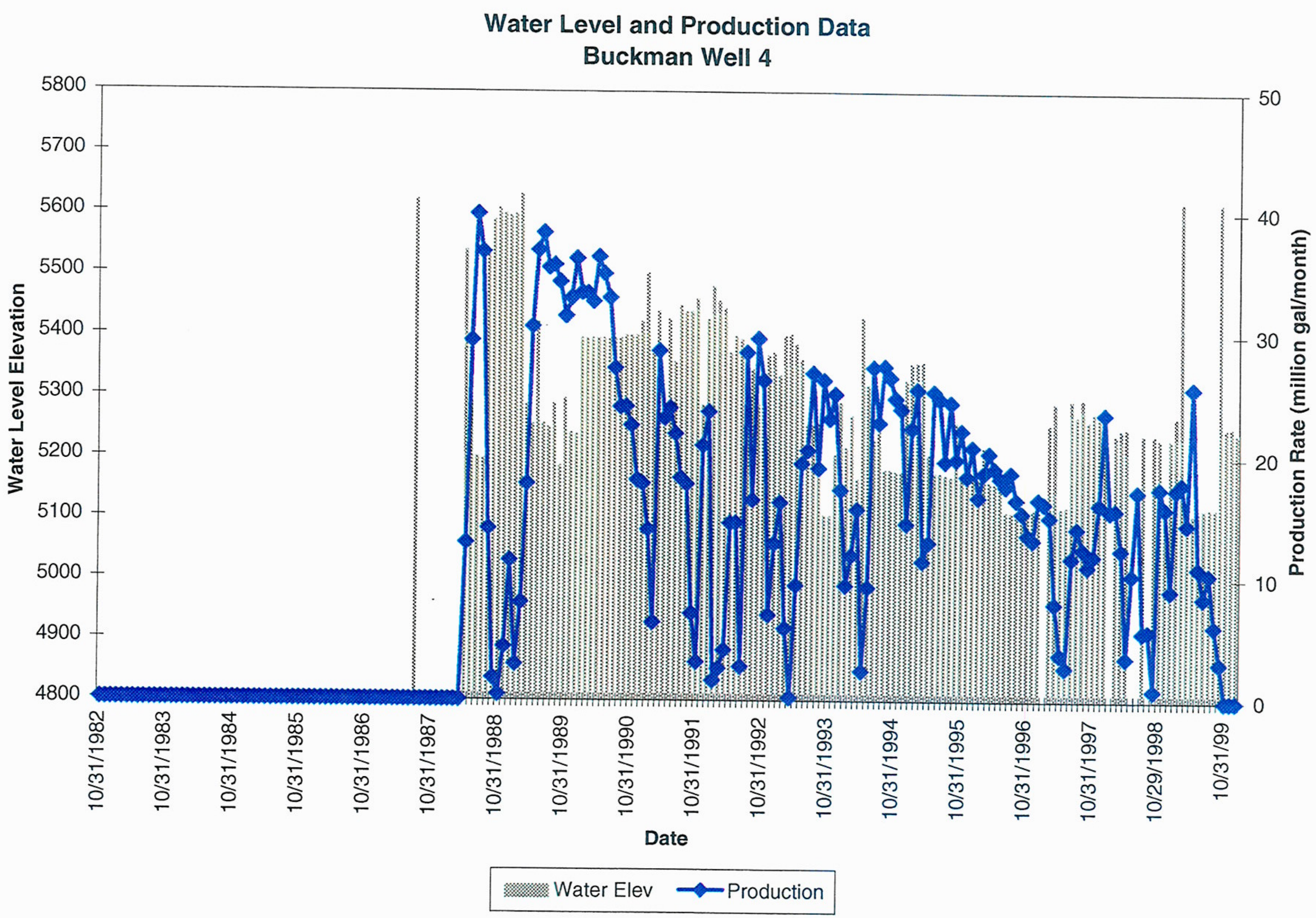

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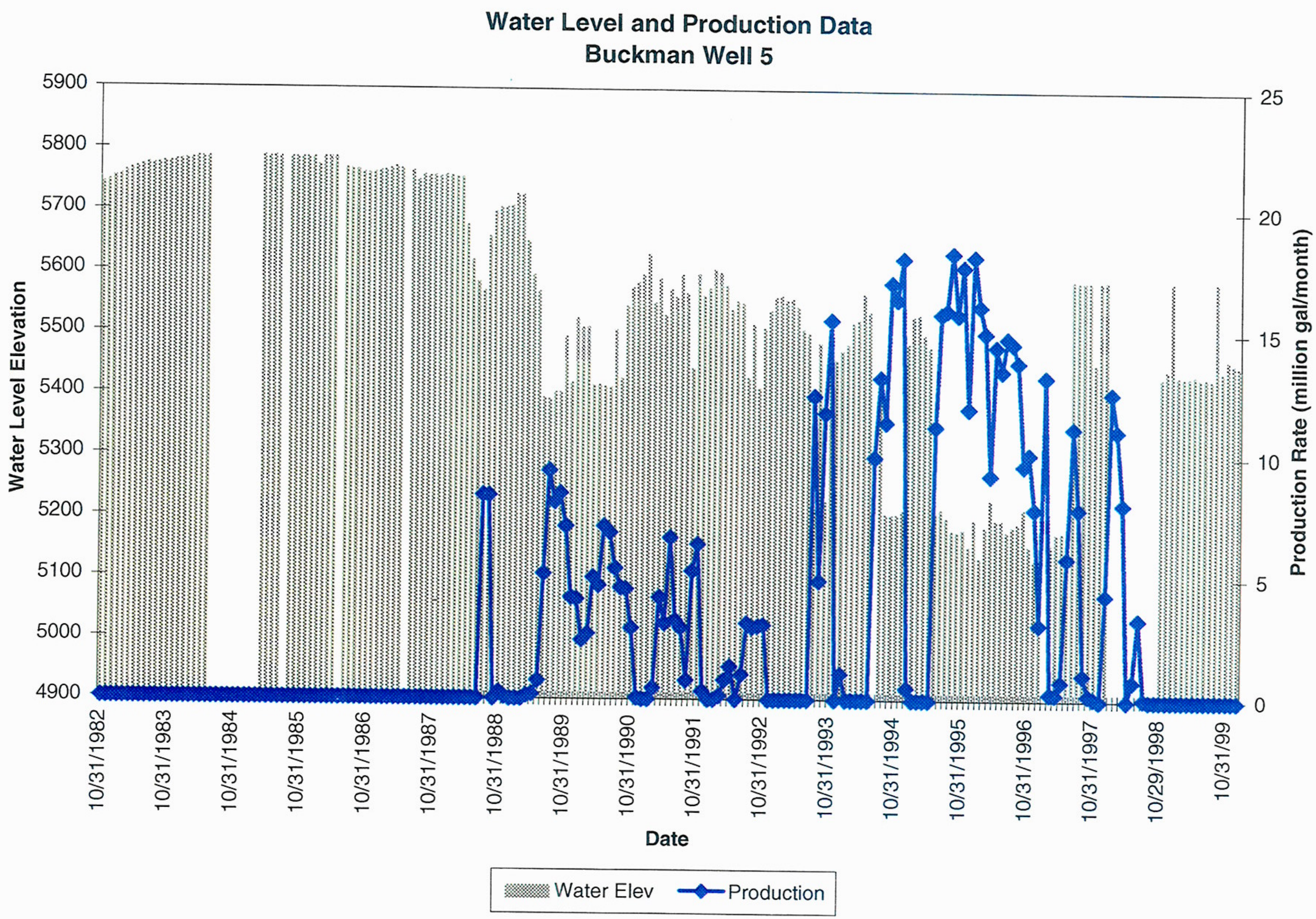

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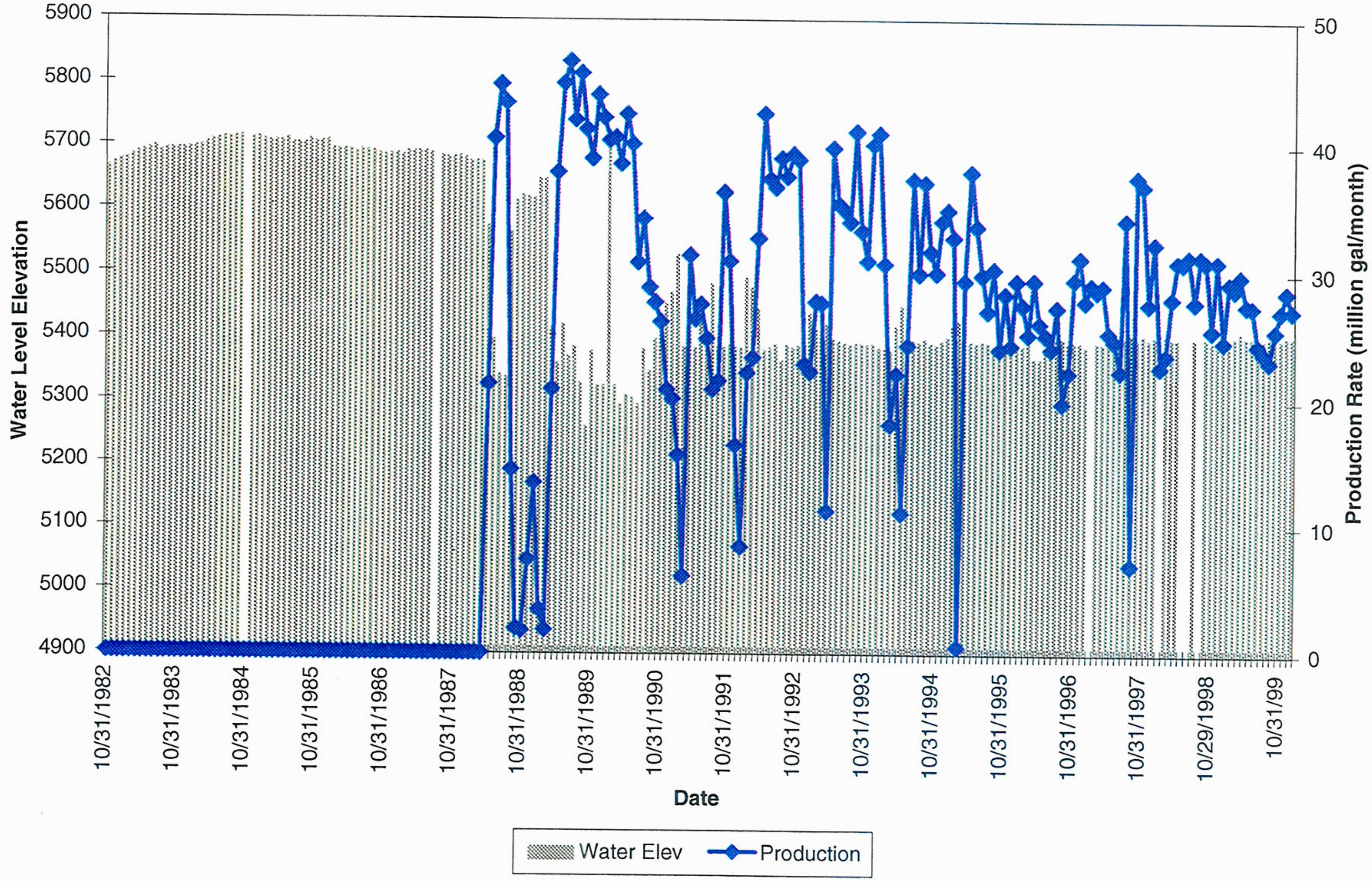
Water Level and Production Data
Buckman Well 6



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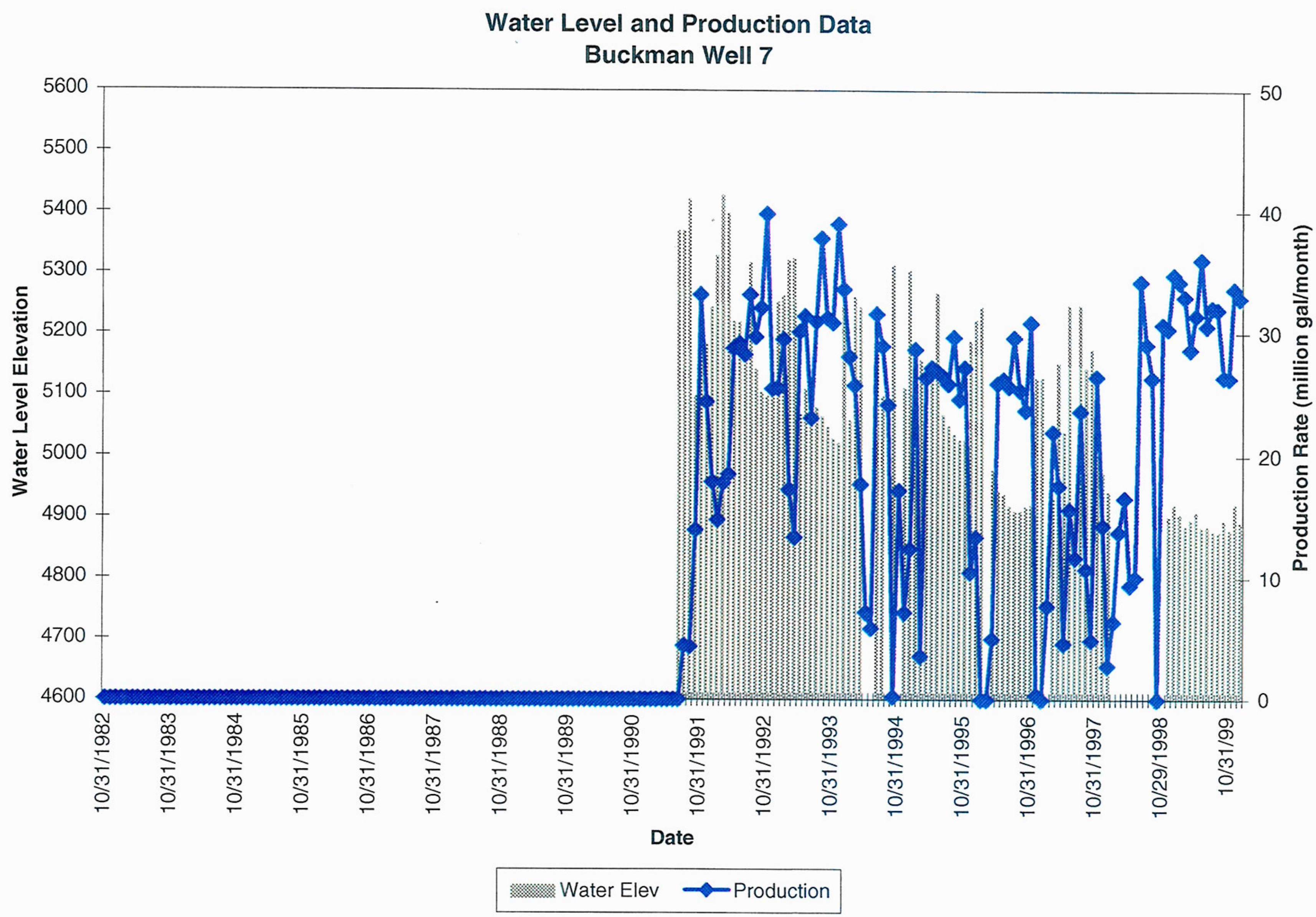

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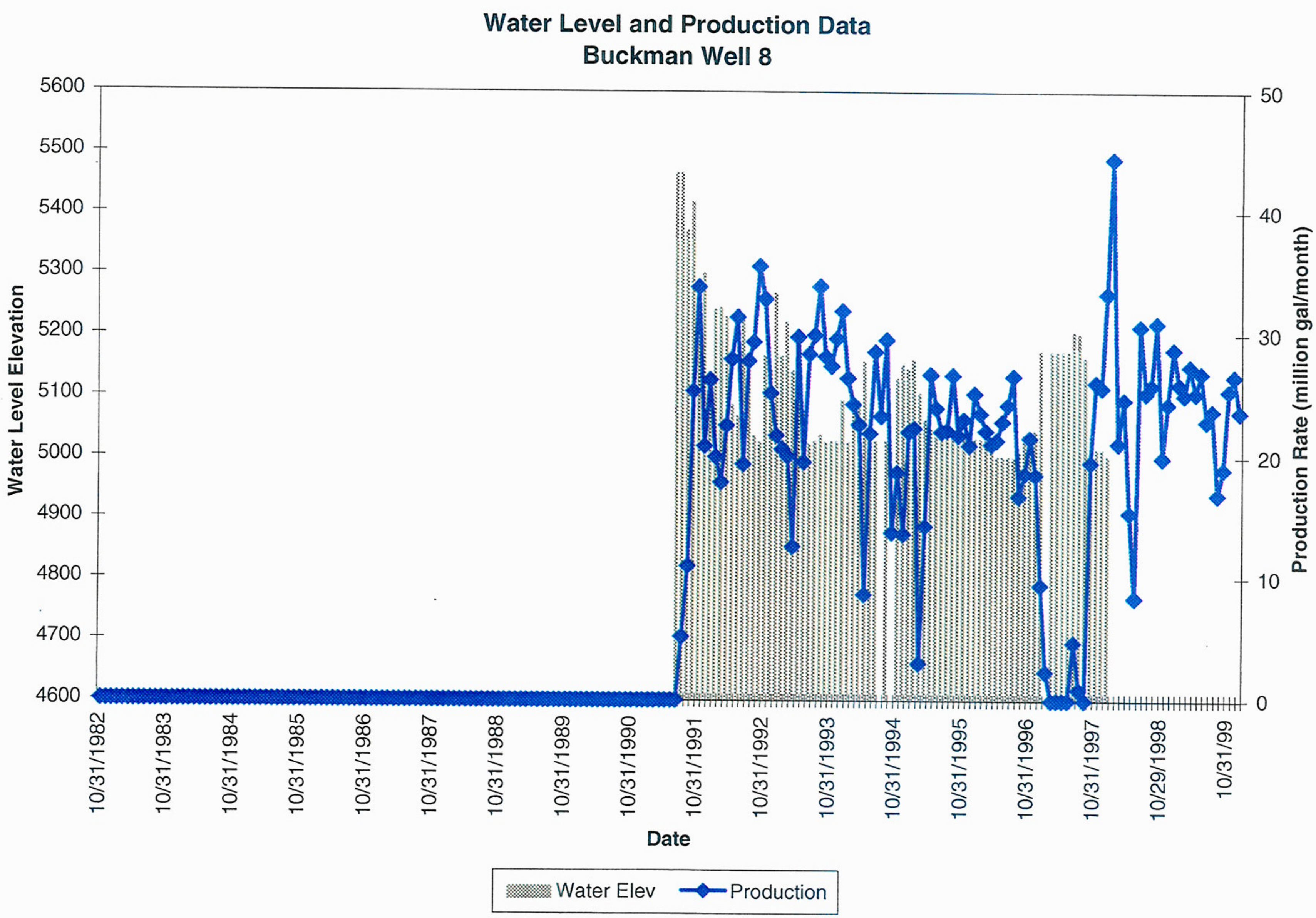


WLE2.xls/Buck8 1/10/2001

Well Data

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Log date	Total	Well	Well	Town	Range	Section	Elevation	Trans	Hydraulic	Aquifer
	drill date	Depth	Depth	Screened				TOC	gpd/ft	Conduct.	
		logged								gpd/ft2	
		ft	ft	ft							
Buckman #1 (old)	9/25/1971	1199			18N	8E	6	5860			Tsf
Buckman #1 (new)	8/6/1977	1108	1093		19N	7E	36.31	5519	5700		Tsf
Buckman #2	6/8/1977	1473			19N	7E	36.43	5539	11000		Tsf
Buckman #3	11/9/1971	1436	1219	500-1490	18N	7E	1.21	5618.51			Tsf
Buckman #4	3/3/1972	1435	1182		18N	7E	1.23	5646.49			Tsf
Buckman #5	4/4/1972	1436	1154		18N	7E	1.43	5789.65			Tsf
Buckman #6	5/12/1972	1409	1410 (951?)		18N	7E	1.44	5725.56			Tsf
Buckman #7	6/12/1905		1415		19N	7E	36.23	5605.5			Tsf
Buckman #7 obs	7/29/1972	1409	957		18N	7E	1	5790			
Buckman #8	1990		910		19N	7E	35.31	5514			
Skillet Observation	7/7/1972	1904	1666		19N	8E	30	5920			Tsf
Weil											
Boondock					19N	8E	22.14	6090			
Permit					18N	8E	2.41	6580			
St Michaels			795	380-780	17N	9E	34.4222	6853.45			
Osage			770	210-760	17N	9E	27.3141	6750			
Santa Fe			1300	200-725	17N	9E	26.133	6871.6			
Agua Fria			740	201-740	17N	9E	27.232	6797.65			
Ferguson			826	175-746	17N	9E	23.3233	6877			
Hickox	1946		216	75-210	17N	9E	26.222	6965			
Hickox No 2	1998	1200	882	400-840	17N	9E	26.222	6964	1250		Tsf
Old Alto			741		17N	9E	23.3322	6861.4			
New Alto St. Well	6/27/1968	740	725	226-720	17N	9E	23.3322				Tsf
Torreon Well No.2	1/10/1997	1225	1230	410-1210	17N	9E	22.441	6829	8600		
Torreon Well			609		17N	9E	22.441	6828			
Country Club Est.			unk		16N	8E	12.1444				
Northwest Well	12/4/1998	2002	2000	500-960,1000-1980	17N	9E	10.431	7120	12000		

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Ref	Lat	Lat	Lat	Long	Long	Long	SEO file	
	for	Deg	Min	Sec	Deg	Min	Sec		
	Aquif.								
	Param	Coord from Environment Department, DWB							
Buckman #1 (old)									
Buckman #1 (new)	a	35	50	6.943	106	9	30.03		
Buckman #2	b	35	49	45.08	106	9	21.65		
Buckman #3		35	49	37.31	106	8	56.37		
Buckman #4		35	49	13.85	106	8	55.82		
Buckman #5		35	48	52.47	106	8	54.32		
Buckman #6		35	49	7.831	106	8	32.6		
Buckman #7		35	50	2.441	106	9	4.537		
Buckman #7 obs									
Buckman #8		35	49	57.87	106	9	52.2		
Skillet Observation									
Weil									
Boondock									
Permit									
St Michaels		35	39	32.7	105.6	57	54.23		
Osage		35	40	21.32	105	58	45.35		
Santa Fe									
Agua Fria		35	40	41.34	105	58	13.78		
Ferguson		35	41	15.87	105	57	25.52		
Hickox									
Hickox No 2	Watson, 1999								
Old Alto									
New Alto St. Well								RG1113	
Torreon Well No.2	d	35	41	5.482	105	58	0.617	RG1115	
Torreon Well									
Country Club Est.		35	37	53.36	106	2	41.97		
Northwest Well		35	42		105	58		RG-68302-ex	

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Log date	Total	Well	Well	Town	Range	Section	Elevation	Trans	Hydraulic	Aquifer
	drill date	Depth	Depth	Screened				TOC	gpd/ft	Conduct.	
		logged								gpd/ft2	
		ft	ft	ft							
SF-1A	9/26/1986	2020	1952	1917-1922	17N	9E	35.131				Tsf
SF-1B	9/26/1986		1060	1025-1030	17N	9E	35.131				Tsf
SF-1C	9/26/1986		780	669-674	17N	9E	35.131				Tsf
SF-2A	10/2/1986	2000	1872	1850-1860	19N	7E	36.311				Tsf
SF-2B	10/2/1986		824	802-812	19N	7E	36.311				Tsf
SF-2C	10/2/1986		356	324-334	19N	7E	36.311				Tsf
SF-3A	11/7/1987		294	274-284				5480			Tsf
SF-3B	11/8/1987		169	149-159				5480			AVMB
SF-3C	11/5/1987		60	40-50				5480			AVMB
SF-4A	########		280	260-270				5470			Tsf
SF-4B	11/2/1987		130	110-120				5470			AVMB
SF-4C	########		60	40-50				5470			AVMB
SF-5A	########		300	280-290				5455			Tsf
SF-5B	########		160	140-150				5455			AVMB
SF-5C	########		69	49-59				5455			AVMB
LA-1	1/1/1946		1001	60-865				5625			Tsf
LA-1B	1/1/1960		2256	326-1694				5620	15700	9.3	Tsf
LA-2	1/1/1946		882	105-865				5650	2500	3.5	Tsf
LA-3	1/1/1947		910	105-865				5670	2500	3.3	Tsf
LA-4	1/1/1948		2019	154-1964				5975	9600	5.7	Tsf
LA-5	1/1/1948		2084	440-1746				5840	4800	3	Tsf
LA-6	1/1/1948		7030	420-1778				5770	15500	9.1	Tsf
G1	1/1/1950		2100	490-1980				5975	12000	7	Tsf
G1A	1/1/1954		2071	563-1513				6015	11000	9.1	Tsf
G2	1/1/1951		2006	425-1990				6055	15000	9.1	Tsf
G3	1/1/1951		1996	400-1785				6140	7500	5.3	Tsf
G4	1/1/1951		2002	360-1925				6230	17500	11.3	Tsf

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Ref	Lat	Lat	Lat	Long	Long	Long	SEO file	
	for	Deg	Min	Sec	Deg	Min	Sec		
	Aquif.								
	Param	Coord from Environment Department, DWB							
SF-1A									
SF-1B									
SF-1C									
SF-2A									
SF-2B									
SF-2C									
SF-3A		35	50	2	106	9	37		
SF-3B		35	50	2	106	9	37		
SF-3C		35	50	2	106	9	37		
SF-4A		35	50	3	106	9	43		
SF-4B		35	50	3	106	9	43		
SF-4C		35	50	3	106	9	43		
SF-5A		35	50	6	106	9	48		
SF-5B		35	50	6	106	9	48		
SF-5C		35	50	6	106	9	48		
LA-1	c								
LA-1B	c								
LA-2	c								
LA-3	c								
LA-4	c								
LA-5	c								
LA-6	c								
G1	c								
G1A	c								
G2	c								
G3	c								
G4	c								

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Log date drill date	Total Depth logged ft	Well Depth ft	Well Screened ft	Town	Range	Section	Elevation TOC	Trans gpd/ft	Hydraulic Conduct. gpd/ft2	Aquifer
G5	1/1/1951		1997	400-1830				6305	12000	8.7	Tsf
G6	1/1/1964		2005	825-1525				6420	6300	6.7	Tsf
PM-1	1/1/1965		2501	945-2494				6520	55000	31	QTp-Tsf
PM-2	1/1/1965		2600	1004-2295				6715	40000	28	QTp-Tsf
PM-3	1/1/1966		2552	956-2547				6640	320000	179	QTp-Tsf
PM-4	1/1/1981		2920	1260-2854				6920	44000	24	QTp-Tsf
PM-5	1/1/1982		3120	1440-3072				7095	10000	5.3	QTp-Tsf
TW-1	1/1/1950		642	-642				6370	200	4	QTp
TW-2	1/1/1949		789	-789				6645	7000	241	QTp
TW-3	1/1/1949		815	-815				6625	7800	120	QTp
TW-4	1/1/1950		1205	-1205				7245	750	19	Tt
TW-5A	1/1/1960		1821	-1821				7145	11000	17	QTp-Tsf
TW-8	1/1/1960		1065	-1065				6870	2400	25	QTp
DT-9	1/1/1960		1501	-1501				6935	61000	122	QTp-Tsf
DT-10	1/1/1960		1409	-1408				7020	36100	111	QTp-Tsf

References

a = Black & Veatch, 1978. Construction and Testing Report Buckman Well No 1

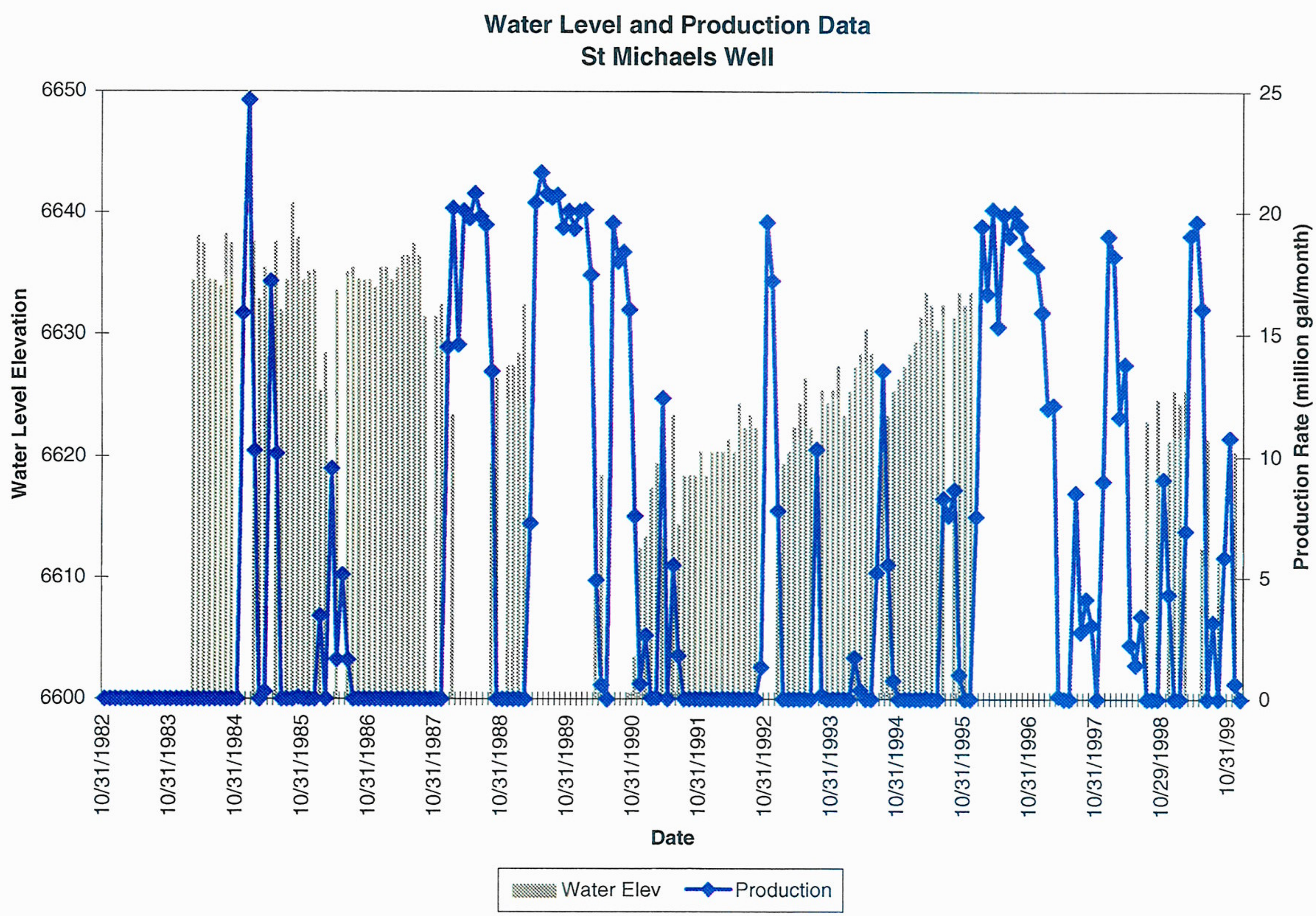
b= Black & Beatch, 1978. Construction and Testing Report Buckman Well No. 2

c = Purtyman, W. D. 1984. Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area: Development of Ground water Supplies

d = Watson, J.B. 1997. Well Report, Drilling, Construction and testing, City of Santa Fe Torreon Well No.2. John Shomaker & Associates, Inc.

Table C-3. Aquifer Parameters from Los Alamos and Santa Fe Municipal Wells

Well Name	Ref	Lat	Lat	Lat	Long	Long	Long	SEO file	
	for	Deg	Min	Sec	Deg	Min	Sec		
	Aquif.								
	Param	Coord from Environment Department, DWB							
G5	c								
G6	c								
PM-1	c								
PM-2	c								
PM-3	c								
PM-4	c								
PM-5	c								
TW-1	c								
TW-2	c								
TW-3	c								
TW-4	c								
TW-5A	c								
TW-8	c								
DT-9	c								
DT-10	c								
References									
a = Black & Veatch									
b= Black & Beatch,									
c = Purtyman, W. D									
d = Watson, J.B. 19									



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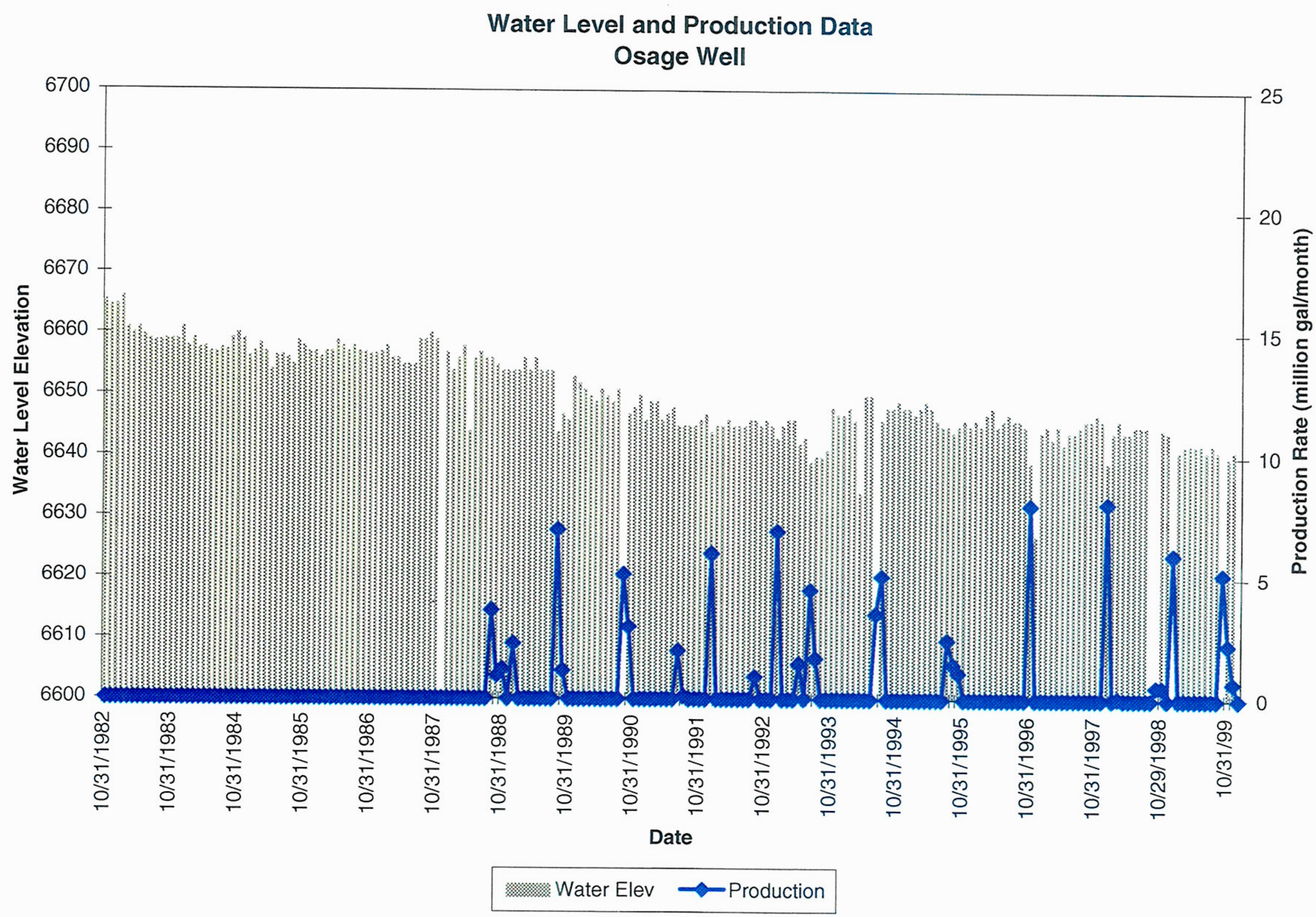

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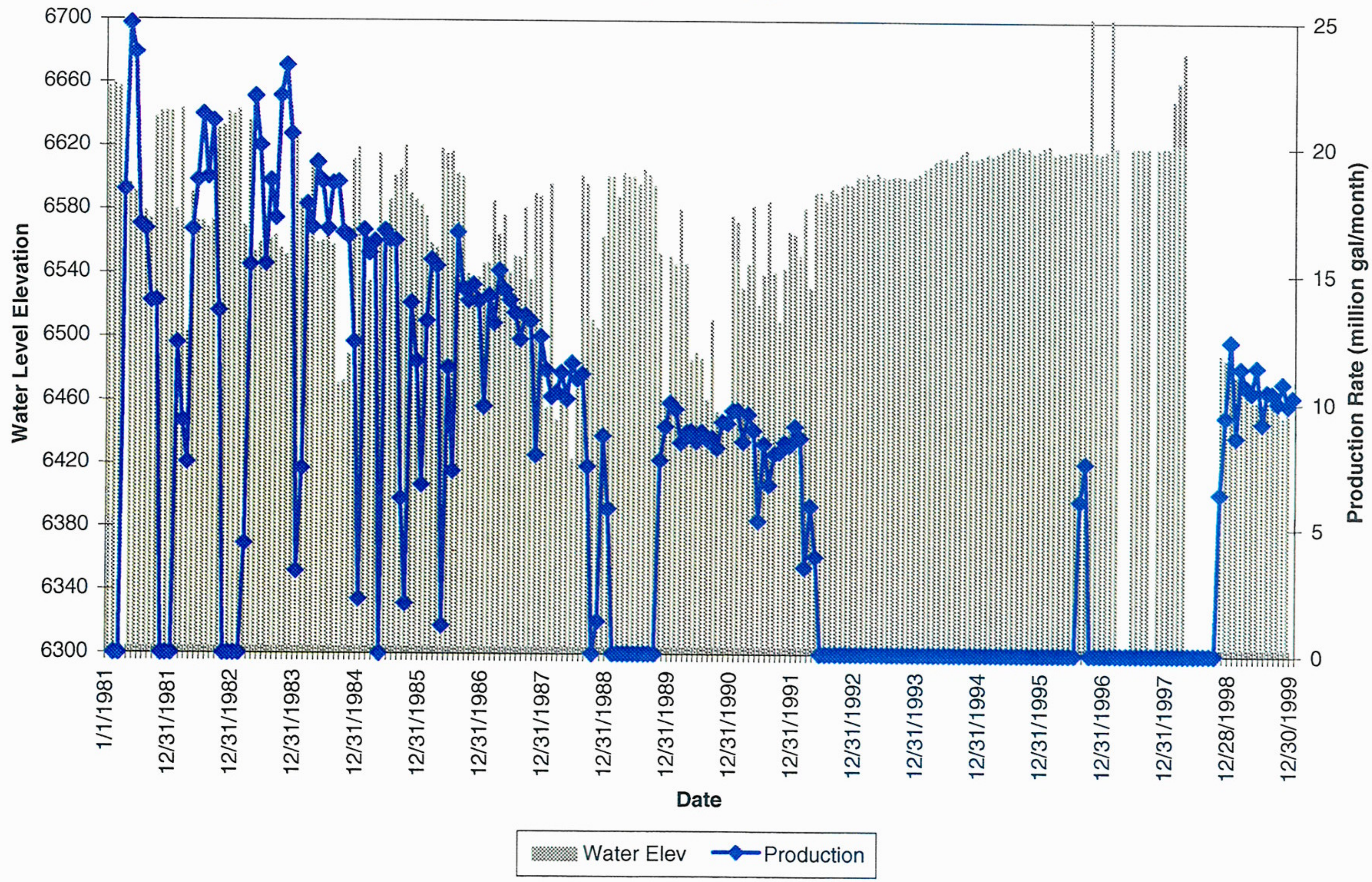
Water Level and Production Data
Santa Fe Well



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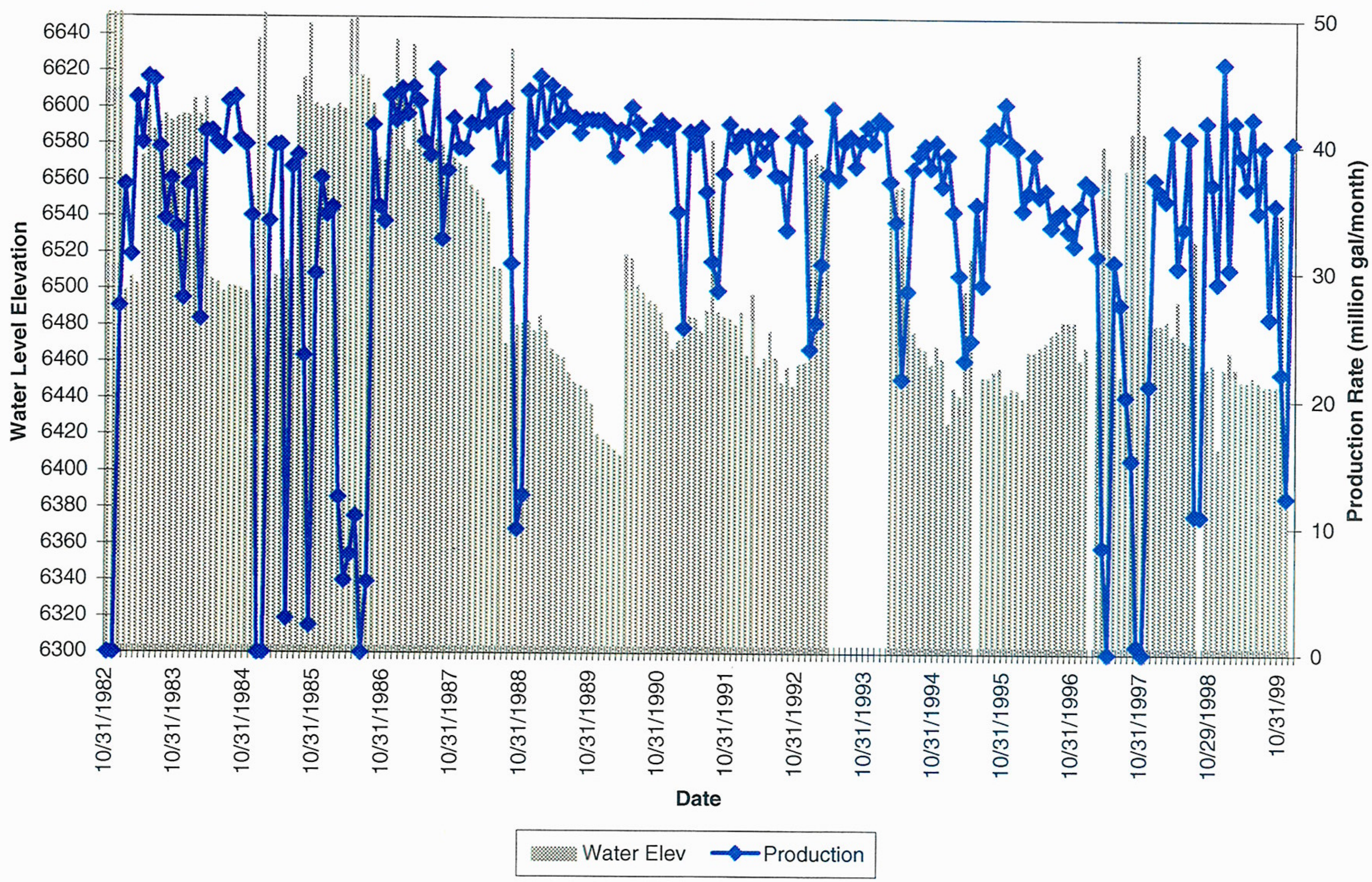
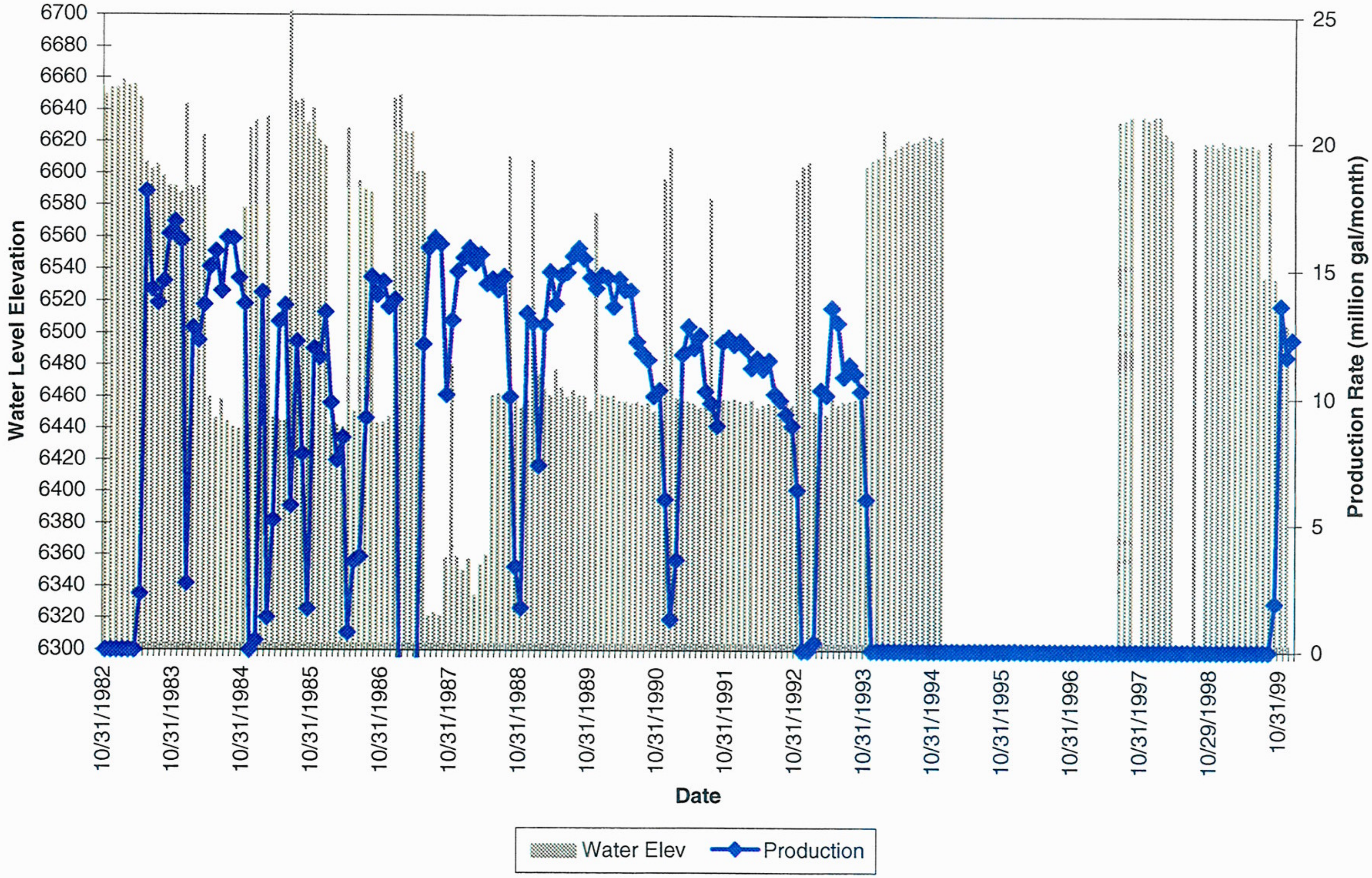
Agua Fria Well



Water Level and Production Data
Alto Well



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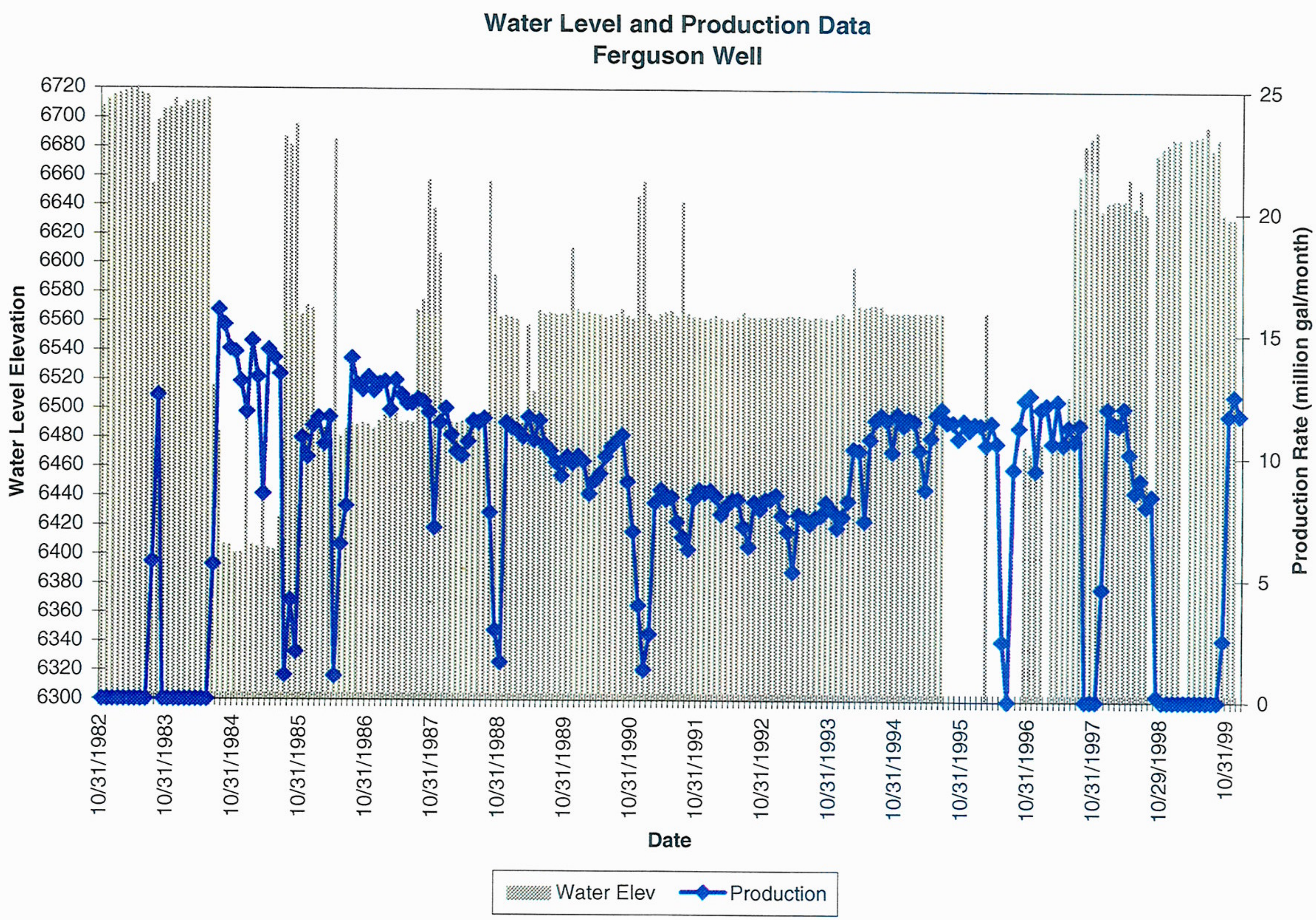

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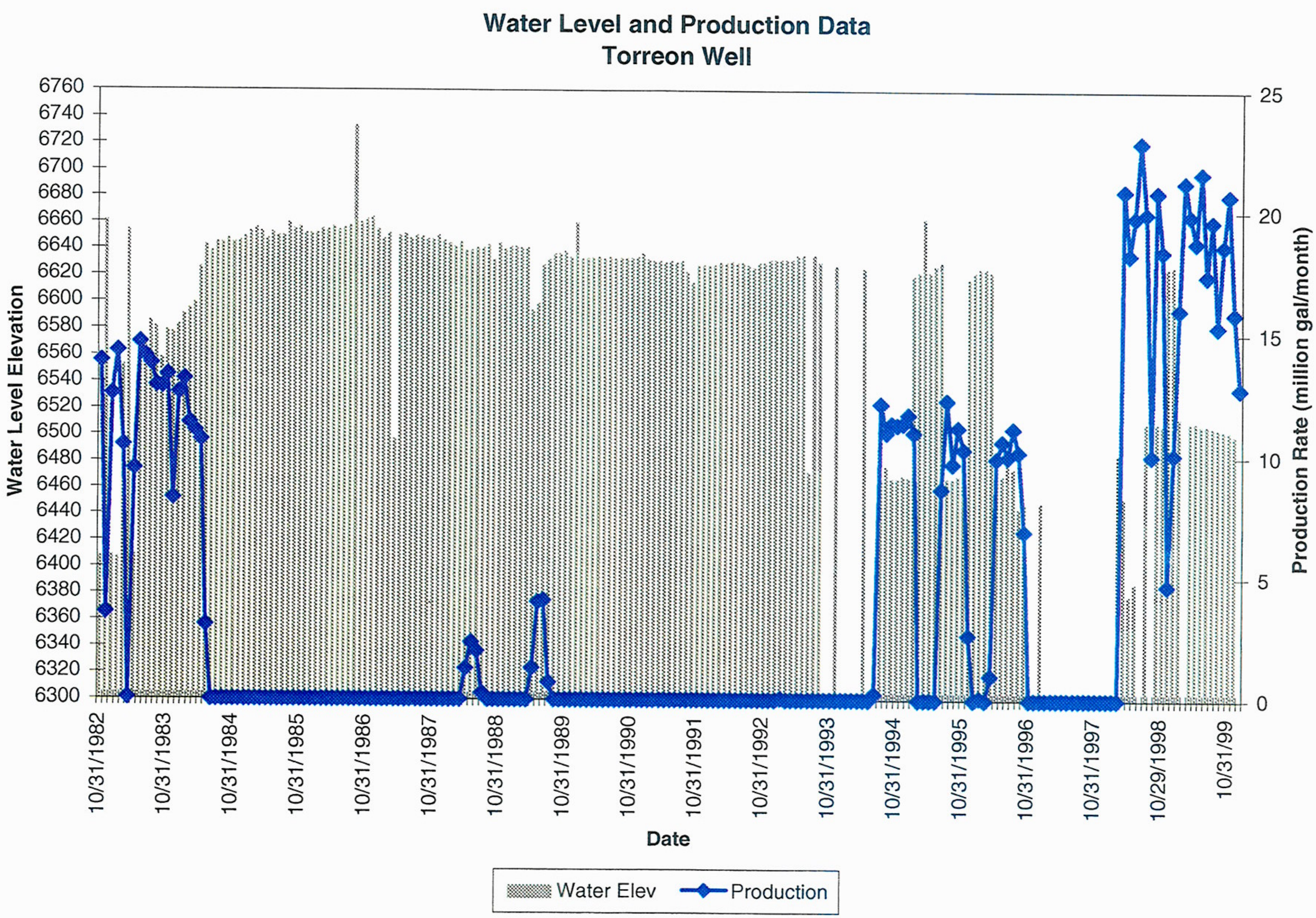

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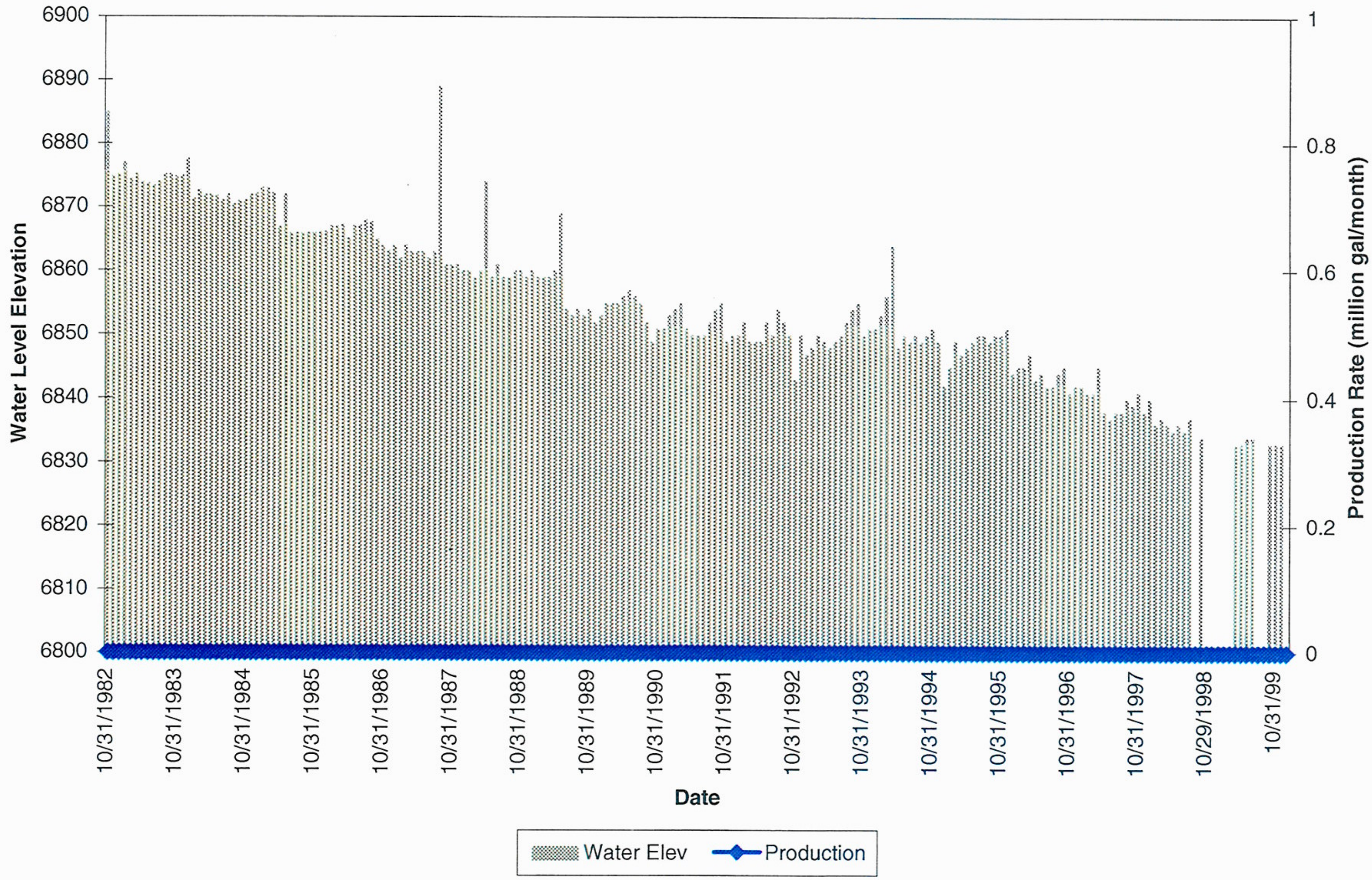
Water Level and Production Data
Hickox Well



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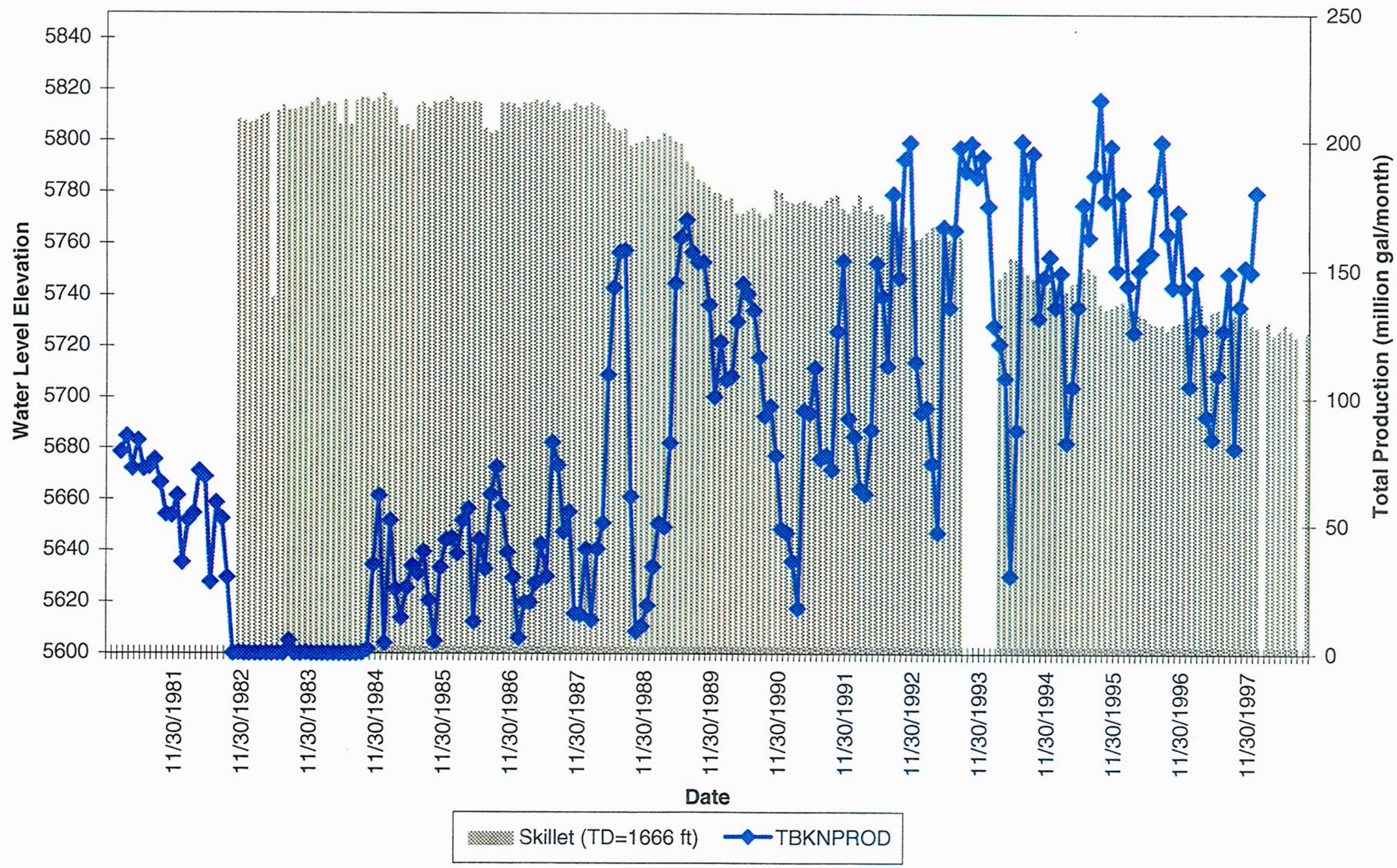
Water Level and Production Data
Skillet Observation Well and Total Buckman Production



WLE2.xls/skillet 1/10/2001

Appendix D
Water Demand Estimates

40 YEAR WATER DEMAND PROJECTIONS FOR SANTA FE

	Urban Area (Low Growth)				Urban Area (High Growth)				Region (Low Growth)					Region (High Growth)				
Year	Pop. Growth Rate[1]	Pop. Growth[1]	Pop.	Water Demand (AFY) [3,4]	Pop. Growth Rate[1]	Pop. Growth[1]	Pop.	Water Demand (AFY) [3,4]	Pop. Growth Rate[1]	Pop. Growth[1]	Region Pop.	Conn-ected Pop.	Water Demand (AFY) [3,4]	Pop. Growth Rate[1]	Pop. Growth[1]	Region Pop.	Conn-ected Pop.	Water Demand (AFY) [3,4]
2000	[2]		**70,000**	**12,000**			**70,000**	**12,000**			**95,000**	**71,250**	**12,200**			**95,000**	**71,250**	**12,200**
2001	1.0%	700	70,700	12,140	1.4%	980	70,980	12,200	1.0%	950	95,950	72,481	12,450	1.2%	1140	96,140	72,671	12,480
2002	1.0%	707	71,410	12,280	1.4%	994	71,970	12,400	1.0%	960	96,910	73,722	12,700	1.2%	1154	97,290	74,106	12,770
2003	1.0%	714	72,120	12,420	1.4%	1008	72,980	12,600	1.0%	969	97,880	74,972	12,950	1.2%	1167	98,460	75,555	13,060
2004	1.0%	721	72,840	12,560	1.4%	1022	74,000	12,800	1.0%	979	98,860	76,232	13,200	1.2%	1182	99,640	77,018	13,350
2005	**1.0%**	**728**	**73,570**	**12,710**	**1.4%**	**1036**	**75,040**	**13,010**	**1.0%**	**989**	**99,850**	**77,502**	**13,450**	**1.2%**	**1196**	**100,840**	**78,495**	**13,650**
2006	1.0%	736	74,310	12,860	1.4%	1051	76,090	13,220	1.0%	999	100,850	78,782	13,710	1.2%	1210	102,050	79,986	13,950
2007	1.0%	743	75,050	13,010	1.4%	1065	77,160	13,430	1.0%	1009	101,860	80,072	13,970	1.2%	1225	103,270	81,492	14,250
2008	1.0%	751	75,800	13,160	1.4%	1080	78,240	13,650	1.0%	1019	102,880	81,372	14,230	1.2%	1239	104,510	83,012	14,550
2009	1.0%	758	76,560	13,310	1.4%	1095	79,340	13,870	1.0%	1029	103,910	82,682	14,490	1.2%	1254	105,760	84,548	14,860
2010	**1.0%**	**766**	**77,330**	**13,460**	**1.4%**	**1111**	**80,450**	**14,090**	**1.0%**	**1039**	**104,950**	**84,002**	**14,750**	**1.2%**	**1269**	**107,030**	**86,098**	**15,170**
2011	1.0%	773	78,100	13,610	1.2%	965	81,420	14,280	1.0%	1050	106,000	85,333	15,020	1.0%	1070	108,100	87,450	15,440
2012	1.0%	781	78,880	13,770	1.2%	977	82,400	14,480	1.0%	1060	107,060	86,674	15,290	1.0%	1081	109,180	88,812	15,710
2013	1.0%	789	79,670	13,930	1.2%	989	83,390	14,680	1.0%	1071	108,130	88,026	15,560	1.0%	1092	110,270	90,185	15,980
2014	1.0%	797	80,470	14,090	1.2%	1001	84,390	14,880	1.0%	1081	109,210	89,388	15,830	1.0%	1103	111,370	91,569	16,260
2015	**1.0%**	**805**	**81,270**	**14,250**	**1.2%**	**1013**	**85,400**	**15,080**	**1.0%**	**1092**	**110,300**	**90,762**	**16,100**	**1.0%**	**1114**	**112,480**	**92,964**	**16,540**
2016	1.0%	813	82,080	14,410	1.2%	1025	86,420	15,280	1.0%	1103	111,400	92,146	16,380	1.0%	1125	113,600	94,370	16,820
2017	1.0%	821	82,900	14,570	1.2%	1037	87,460	15,490	1.0%	1114	112,510	93,541	16,660	1.0%	1136	114,740	95,787	17,100
2018	1.0%	829	83,730	14,740	1.2%	1050	88,510	15,700	1.0%	1125	113,640	94,948	16,940	1.0%	1147	115,890	97,216	17,390
2019	1.0%	837	84,570	14,910	1.2%	1062	89,570	15,910	1.0%	1136	114,780	96,365	17,220	1.0%	1159	117,050	98,656	17,680
2020	**1.0%**	**846**	**85,420**	**15,080**	**1.2%**	**1075**	**90,640**	**16,120**	**1.0%**	**1148**	**115,930**	**97,794**	**17,510**	**1.0%**	**1171**	**118,220**	**100,108**	**17,970**
2021	1.0%	854	86,270	15,250	1.2%	1088	91,730	16,340	1.0%	1159	117,090	99,235	17,800	1.0%	1182	119,400	101,571	18,260
2022	1.0%	863	87,130	15,420	1.2%	1101	92,830	16,560	1.0%	1171	118,260	100,687	18,090	1.0%	1194	120,590	103,046	18,560
2023	1.0%	871	88,000	15,590	1.2%	1114	93,940	16,780	1.0%	1183	119,440	102,151	18,380	1.0%	1206	121,800	104,533	18,860
2024	1.0%	880	88,880	15,770	1.2%	1127	95,070	17,010	1.0%	1194	120,630	103,627	18,680	1.0%	1218	123,020	106,033	19,160
2025	**1.0%**	**889**	**89,770**	**15,950**	**1.2%**	**1141**	**96,210**	**17,240**	**1.0%**	**1206**	**121,840**	**105,114**	**18,980**	**1.0%**	**1230**	**124,250**	**107,544**	**19,460**
2026	1.0%	898	90,670	16,130	1.2%	1155	97,360	17,470	1.0%	1218	123,060	106,614	19,280	1.0%	1243	125,490	109,068	19,760
2027	1.0%	907	91,580	16,310	1.2%	1168	98,530	17,700	1.0%	1231	124,290	108,126	19,580	1.0%	1255	126,740	110,604	20,070
2028	1.0%	916	92,500	16,490	1.2%	1182	99,710	17,940	1.0%	1243	125,530	109,650	19,880	1.0%	1267	128,010	112,153	20,380
2029	1.0%	925	93,430	16,680	1.2%	1197	100,910	18,180	1.0%	1255	126,790	111,186	20,190	1.0%	1280	129,290	113,714	20,690
2030	**1.0%**	**934**	**94,360**	**16,870**	**1.2%**	**1211**	**102,120**	**18,420**	**1.0%**	**1268**	**128,060**	**112,735**	**20,500**	**1.0%**	**1293**	**130,580**	**115,288**	**21,000**
2031	1.0%	944	95,300	17,060	1.2%	1225	103,350	18,670	1.0%	1281	129,340	114,297	20,810	1.0%	1306	131,890	116,875	21,320
2032	1.0%	953	96,250	17,250	1.2%	1240	104,590	18,920	1.0%	1293	130,630	115,872	21,120	1.0%	1319	133,210	118,475	21,640
2033	1.0%	963	97,210	17,440	1.2%	1255	105,850	19,170	1.0%	1306	131,940	117,459	21,440	1.0%	1332	134,540	120,089	21,960
2034	1.0%	972	98,180	17,630	1.2%	1270	107,120	19,420	1.0%	1319	133,260	119,060	21,760	1.0%	1345	135,890	121,715	22,290
2035	**1.0%**	**982**	**99,160**	**17,830**	**1.2%**	**1285**	**108,410**	**19,680**	**1.0%**	**1333**	**134,590**	**120,674**	**22,080**	**1.0%**	**1359**	**137,250**	**123,356**	**22,620**
2036	1.0%	992	100,150	18,030	1.2%	1301	109,710	19,940	1.0%	1346	135,940	122,301	22,410	1.0%	1373	138,620	125,009	22,950
2037	1.0%	1002	101,150	18,230	1.2%	1317	111,030	20,200	1.0%	1359	137,300	123,942	22,740	1.0%	1386	140,010	126,677	23,280
2038	1.0%	1012	102,160	18,430	1.2%	1332	112,360	20,470	1.0%	1373	138,670	125,596	23,070	1.0%	1400	141,410	128,358	23,620
2039	1.0%	1022	103,180	18,630	1.2%	1348	113,710	20,740	1.0%	1387	140,060	127,264	23,400	1.0%	1414	142,820	130,053	23,960
2040	**1.0%**	**1032**	**104,210**	**18,840**	**1.2%**	**1365**	**115,070**	**21,010**	**1.0%**	**1401**	**141,460**	**128,946**	**23,740**	**1.0%**	**1428**	**144,250**	**131,763**	**24,300**

Notes:
1) Growth rate is from previous year to year listed. Initial growth values (for 2000 through 2020) based on General Plan.
2) 2000 demands estimated based on late 1990s growth and demand patterns.
   Regional demand assumes that in 2000, 5% of non-urban DUs are connected, with incremental connections each yr, until ultimately, 50% of non-urban DUs are connected in 2040.
3) Persons per new DU = **2.0**
4) Water demand (AFY/ new DU) = **0.4**

Appendix E
City of Santa Fe Water Rate Structure

CITY OF SANTA FE

Sangre De Cristo Water
Water Rate Schedules
January 12, 2000

	Rate Schedule 1	Rate Schedule 2	Rate Schedule 3	Rate Schedule 5	Rate Schedule 6	Rate Schedule 9
	Residential 212	Small Commercial 222	Large Commercial 223	Private Fire Hydrants 462	Fire Service Line 362	Municipal Fire Hydrants 461
Commodity Charge per 1000 Gallons						
Feb. 1, 2000	$ 3.50	$ 2.70	$ 2.70			
May 1, 2000	$ 3.64	$ 2.81	$ 2.81			
May 1, 2001	$ 3.79	$ 2.92	$ 2.92			
May 1, 2002	$ 3.94	$ 3.04	$ 3.04			
May 1, 2003	$ 4.09	$ 3.16	$3.16			
Monthly Service Charges:						
5 / 8 " meter	$ 6.94	$ 14.68				
3 / 4" meter	$ 7.50	$ 20.86				
1" meter	$ 8.61	$ 33.22				
1 - ½" meter	$ 18.66	$ 64.12				
2" meter	$ 19.34	$ 101.19				
3" meter	$ 29.23	$ 195.13				
4" meter			$ 231.82			
6" meter			$ 461.32			
8" meter			$ 736.72			
3" fire service line					$ 21.19	
4" fire service line					$ 34.68	
6" fire service line					$ 68.39	
8" fire service line					$ 108.84	
10" fire service line					$ 159.89	
Fire Hydrant Annual Charge				$ 54.52		$ 46.72

2/28/00 dmf

Summer Surcharges & Rebates - May through October (in addition to Commodity Charge):

Commercial Customers Conservation Surcharge: $1.00 per 1,000 gallons on all usage.

Residential Customers Conservation Surcharge: $2.50 per 1,000 gallons for usage above 12,000 up to 20,000 gallons
$5.00 per 1000 gallons for usage above 20,000 gallons

Residential Customer Rebate: $2.00 credit per 1,000 gallons below 8,000 gallons (Note: rebate can never be larger than the Gallons Charge)

CITY OF SANTA FE

Sangre De Cristo Water
Water Rate Schedules
January 12, 2000

SCHEDULE 7 - BASE METER SERVICE CHARGES

Note: Total Base Meter Service Charge consists of Section A + Section B + Section C

SECTION A

	¾" Service	1" Service	1 ½ " Service	2" Service
Dirt or Gravel	$ 554.75	$ 592.23	$ 1,372.43	$ 1,542.87
Paved	$ 1,026.83	$ 1,064.31	$ 1,876.31	$ 2,046.74
Back of Curb			$ 1,276.80	$ 1,447.24

SECTION B

Any cost related to the excavation or the restoration of street and road surfaces, curbs and gutters and sidewalks, including governmental permits, as may be required in compliance with applicable state or local government statutes, ordinances or regulations.

SECTION C

Billings under this Schedule may be increased by an amount equal to the sum of taxes payable under the Gross Receipts and Compensating Tax Act and of all other taxes, fees, or charges payable by the City and levied or assessed by any governmental authority on the public utility service rendered, or on the right or privilege of rendering the service, or on any object or event incidental to the rendition of the service.

SCHEDULE 8 - UTILITY EXPANSION CHARGES

Note: Total Utility Expansion Charge consists of Section A + Section B

SECTION A

Meter Service	EQM Factor (x $ 2, 013)	UEC
5/8" - Low priced dwelling unit	NA	$ 800
5/8"	1.0	$ 2,013
¾"	1.5	$ 3,019
1"	2.5	$ 5,032
1 ½"	5.0	$ 10,065
2"	8.0	$ 16,104
3"	15.6	$ 31,402
4"	25.0	$ 50,325
6"	50.0	$ 100,650
8"	80.0	$ 161,040

SECTION B

Billings under this Schedule may be increased by an amount equal to the sum of taxes payable under the Gross Receipts and Compensating Tax Act and of all other taxes, fees, or charges payable by the City and levied or assessed by any governmental authority on the public utility service rendered, or on the right or privilege of rendering the service, or on any object or event incidental to the rendition of the service.

CITY OF SANTA FE

Sangre De Cristo Water
Water Rate Schedules
January 12, 2000

SCHEDULE 4 - SPECIAL CHARGES

Note: All Special Charges are subject to gross receipts tax or other governmental taxes, fees or charges.

SPECIAL CHARGE	AMOUNT
Collection Charge	$7.50
Reconnect Charge	During Business Hours: $ 7.50 After Normal Business Hours: $ 51.00
Returned Bank Checks or Bank Drafts	$ 15.00
Customer Deposits:	
Security Deposits	See Rule No. 6
Guarantees of Payments	See Rule No. 6 Minimum: $ 10.00 Maximum: (1/6) x (the annual billings), or (1.5) x (estimated monthly billing)
Meter Tests:	
If a test has been performed within the past 12 months	Cost = the journeyman pipefitter's hourly rate of pay. Cost if refunded if the meter is more than 2% in error against the customer.
For City-Owned Facilities	One estimate per facility allowed. Thereafter, a charge for additional estimates for each facility may apply

2/28/00 dmf

Appendix F
Example of Annual Water Quality Report

CITY OF SANTA FE
SANGRE DE CRISTO WATER DIVISION
P.O. Box 909, Santa Fe, NM 87504
Customer Service (505) 982-3700 or Administration (505) 954-7120

1998 WATER QUALITY REPORT

This is an annual report on the quality of water delivered by Sangre De Cristo Water Division. It meets the federal Safe Drinking Water Act (SDWA) requirement for "Consumer Confidence Reports" and contains information on the source of our water, its constituents, and the health risks associated with any contaminants on the SDWA list. Safe water is vital to our community and is the primary mission of SDCW. Please read this report carefully and, if you have questions, comments or suggestions, please contact Robert Jorgensen at 505-954-7127 (e-mail: rjorgen@pnm.com).

Este sumario contiene información importante sobre la calidad del agua en Santa Fe. Tradúzcalo, hable con alguien que lo entienda bien, o llame Vioma Trujillo a 505-954-7161 (e-mail: vtrujil1@pnm.com).

The bottom line: Is Santa Fe's water safe to drink? . . . . . .Absolutely.

Call us for information about the next opportunity for public participation in decisions about our drinking water. Consult the City of Santa Fe's Web site at www.ci.santa-fe.nm.us and, for further information, see U.S. Environmental Protection Agency (EPA) water information at www.epa.gov/safewater.

OVERVIEW

Sangre De Cristo Water Division supplies drinking water to consumers within Santa Fe and the surrounding vicinity through more than 27,000 metered water service connections. Water supplied to consumers must meet federal and state water quality requirements. Treated water from each water source (each water well and the Santa Fe Canyon Surface Water Treatment Plant) and within the distribution system is tested for more than 70 potential contaminants. Testing is done in accordance with EPA and New Mexico Environment Department (NMED) requirements. Testing schedules vary for each contaminant on the federal list (*e.g.*, turbidity monitoring is done continuously and radiological testing is done once every 4 years).

The City of Santa Fe has made numerous water system improvements since purchasing the water system in mid-1995 to improve water quality. Water quality and water supply improvements include:

- the complete rebuilding of the Torreon Well and pump station
- installation of a new treatment system for the Santa Fe Well and Alto Well to clean up shallow groundwater contaminants
- rehabilitation of both the Alto and Ferguson Wells
- addition of a new northwest sector well
- replacement of the Hickox Well
- operational and structural improvements made to the Surface Water Treatment Plant to improve efficiency and water quality
- repainting of the St. Johns and Dempsey water storage tanks
- replacement of chlorine gas disinfectant with mixed oxidant disinfectants which are generated onsite from salt
- numerous replacements and upgrades of water mains and water service lines
- planning of a major water diversion project at the Rio Grande
- the implementation of the City's water conservation program.
- replacing obsolete equipment, acquiring backup power supply for unanticipated power outages, and upgrading the remote operating and monitoring system in response to Y2K concerns.

All of these efforts have been performed to meet the mission of SDCW: " Sangre De Cristo Water is dedicated to providing the highest quality water service possible to the citizens of Santa Fe in a reliable and cost effective manner."

WATER SOURCES

Santa Fe's water is a mix of three water sources, as illustrated on the map. The three sources are surface water, the City well field supply, and the Buckman well field supply. During a "normal" water year, these supplies are produced to meet demands from each source at 40%, 20% and 40%, respectively, for a total demand of 3.5-4.5 billion gallons per year. Source water enters a common distribution system and is mixed together within the distribution pipes. The proportion of each water source that a consumer receives varies with the consumer's location; the proportion is also affected by the time of year and water available from each of the sources.

Santa Fe's highest quality water originates from the pristine 25 square miles in the upper Santa Fe River watershed and is stored in McClure Reservoir and Nichols Reservoir. Total storage capacity is 3,950 acre-feet or 1.3 billion gallons. Surface water is treated at the Water Treatment Plant located at the east end of Canyon Road and then enters the water distribution system. To protect the

CONCERNING NITRATE IN OUR WATER

Nitrate in drinking water at levels above 10 ppm is a health risk for infants of less than six months of age. High nitrate levels in drinking water can cause blue baby syndrome. Nitrate levels may rise quickly for short periods of time because of rainfall or agricultural activity. If you are caring for an infant you should ask advice from your health care provider.

CONCERNING RADON

Radon is a radioactive gas that you can't see, taste, or smell. It is found all over the United States. Radon can move up through the ground and into a home through cracks and holes in the foundation. Radon can build up to high levels in all types of homes. Radon can also get into indoor air when released from tap water from showering, washing dishes, and other household activities. Compared to radon entering the home through soil, radon entering the home through tap water will in most cases be a small source of radon in indoor air. Radon is a known human carcinogen. Breathing air containing radon can lead to lung cancer. Drinking water containing radon may also cause increased risk of stomach cancer. If you are concerned about radon in your home, test the air in your home. Testing is inexpensive and easy. Repair your home if the level of radon in your air is 4 picocuries per liter of air (pCi/L) or higher. There are simple ways to fix a radon problem that aren't too costly. For additional information, call your state radon program or call EPA's Radon Hotline (800-SOS-RADON).

REQUIRED ADDITIONAL HEALTH INFORMATION

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and aquifers. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and radioactive material, and can pick up substances resulting from the presence of animals or from human activity. Contaminants that may be present in source water include:

- <u>Microbial contaminants</u>, such as viruses and bacteria, which may originate from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- <u>Inorganic contaminants</u>, such as salts and metals, that naturally occur or result from urban storm runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- <u>Pesticides and herbicides</u> that may originate from a variety of sources such as agriculture, stormwater runoff, and residential uses.
- <u>Organic chemical contaminants</u>, including synthetic and volatile organics that are by-products of industrial processes and petroleum production, and can also originate from gas stations, urban stormwater runoff and septic systems.
- <u>Radioactive contaminants</u> that are naturally occurring or are the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, EPA prescribes regulations which limit the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled water that must provide the same protection for public health. Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium are available from the Safe Drinking Water Hotline (800-426-4791).

AN EXPLANATION OF THE WATER QUALITY TABLE

The table shows the results of our water quality analyses. The data presented in this report is from the most recent testing done in accordance with regulations.

Every regulated contaminant detected in the water, even in the most minute traces, is listed here. The table contains the name of each substance, the highest level allowed by regulation, the ideal goals for public health, the amount detected, the usual sources of such contamination, footnotes explaining our findings, and a key to the units of measurement. Definitions of MCL and MCLG are important. Tests were conducted for more than 50 additional contaminants; none of these contaminants were detected in our water.

1998 Water Quality Table - Sangre De Cristo Water Division

Contaminant	Date Tested	Unit	MCL	MCLG	Detected Level [1]	Range [1]	Major Sources	Violations
Inorganic Contaminants								
Arsenic	1997	ppb	50	0	9	nd - 9	Erosion of natural deposits, runoff from orchards, runoff from glass and electronics production wastes	No
Lead	1998	ppb	AL=15	0	7	1 site above AL out of 30 sites sampled	Corrosion of household plumbing systems, erosion of natural deposits	No
Barium	1997	ppm	2	2	0.5	nd - 0.5	Discharge of drilling wastes, discharge from metal refineries, erosion of natural deposits	No
Chromium	1997	ppb	100	100	8	nd - 8	Discharge from steel and pulp mills, erosion of natural deposits	No
Nitrate	1998	ppm	10	10	5.6 AL [4]	nd - 6.3	Runoff from fertilizer use, leaching from septic tanks, sewage, erosion of natural deposits	No
Copper	1998	ppm	AL=1.3	AL=1.3	0.53	0 sites above AL out of 30 sites sampled	Corrosion of household plumbing systems, erosion of natural deposits, leaching from wood preservatives	No
Fluoride	1997	ppm	4	4	0.7 [5]	nd - 0.7	Erosion of natural deposits, water additive which promotes strong teeth, discharge from fertilizer and aluminum factories	No
Radiological Contaminants								
Combined radium 226/228	1997	pCi/L	5	0	1.6	0.1 - 1.6	Erosion of natural deposits	No
Beta/photon emitters	1997	pCi/L	50 [2]	0	38	nd - 38	Decay of natural and manmade deposits	No
Alpha emitters	1997	pCi/L	15	0	83	nd - 83	Erosion of natural deposits	No [3]
Volatile Organic Contaminants								
Total Trihalomethanes	1998	ppb	100	0	26	nd - 74.7	By-product of drinking water chlorination	No

Water Quality Table Footnotes:

1 These columns show the results of tests on our finished water.

2 EPA considers 50 pCi/L to be the level of concern for beta particles. The MCL is 4 mrem/yr.

3 Alpha Emitters: The level of alpha emitters shown in the table is higher than the MCL. No violation has occurred as the method of calculating the level of alpha emitters has been revised after the 1997 compliance testing.
Alpha Emitter Health Effects: Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.
Action: Buckman well water is mixed together and the concentration of alpha emitters is reduced. Follow-up testing is being scheduled.

4 Nitrate: The AL (greater than 5 ppm) was exceeded.
Action Taken: Quarterly sampling instead of annual sampling; also, Torreon Well was redrilled which significantly reduced nitrate levels.

5 Fluoride: Table lists naturally occurring fluoride levels. More fluoride is added to drinking water to achieve a 1.0 - 1.2 ppm level to prevent dental carries.

Terms and Abbreviations:

AL = **Action Level.** The concentration of a contaminant which, if exceeded, triggers treatment or other requirement that a water system must follow.

MCL = **Maximum Contaminant Level.** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

MCLG = **Maximum Contaminant Level Goal.** The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

TT = **Treatment Technique.** A required process intended to reduce the level of a contaminant in drinking water.

mrem/yr = **millirems per year** - a measure of radiation absorbed by the body

nd = **not detectable** at testing limit

pCi/L = **picocuries per liter** - a measure of radioactivity

ppb = **parts per billion**, or micrograms per liter (μg/L)

ppm = **parts per million**, or milligrams per liter (mg/L)

Variances & exemptions State or EPA permission not to meet an MCL or a treatment technique under certain conditions.

Appendix G
Projections of Offsetting Rights on Pojoaque and Tesuque

Appendix G
Projections of Offsetting Rights on Pojoaque and Tesuque

The following projections of required rights to offset Buckman pumping are taken from a run of the SEO annual groundwater model made in 1993. Actual pumping is used through 1992, and projected pumping of 4,800 AF annually is used after that year. Inasmuch as pumping has been higher than 4,800 AF since 1992, these estimates were increased by a factor calculated as the ratio of the requirement calculated by the SEO model run for 1999 to the requirement for 1999 calculated by the 1993 run. The required rights include both those called for by the McAda-Waciolek model and the residual effects of the pre-1988 analytical model.

Offsetting rights on the Pojoaque-Nambe

Year	Required Rights (acre-feet)	Rights Owned (acre-feet)			Additional Rights Required
		By City	By Las Campanas	Total	
2000	51.03	51.252	13.571	64.823	--
2005	57.83	51.252	13.571	64.823	--
2010	67.90	51.252	13.571	64.823	3.08
2015	79.25	51.252	13.571	64.823	14.43
2020	91.29	51.252	13.571	64.823	26.47
2025	102.86	51.252	13.571	64.823	38.04
2030	114.20	51.252	13.571	64.823	49.38
2035	125.28	51.252	13.571	64.823	60.46
2040	135.94	51.252	13.571	64.823	71.12

Offsetting rights on the Tesuque

Year	Required Rights (acre-feet)	Rights Owned (acre-feet)			Additional Rights Required
		By City	By Las Campanas	Total	
2000	31.89	30.995	18.775	49.77	--
2005	32.47	30.995	18.775	49.77	--
2010	33.28	27.995	18.775	46.77	--
2015	34.38	27.995	18.775	46.77	--
2020	35.75	27.995	18.775	46.77	--
2025	37.26	27.995	18.775	46.77	--
2030	39.22	27.995	18.775	46.77	--
2035	41.15	27.995	18.775	46.77	--
2040	43.44	27.995	18.775	46.77	--

Note: originally calculated requirements, and adjustment factor applied to take account of post-1992 pumping greater than 4,800 AF are as follows:

Year	Poj-Nambe	Tesuque
2000	48.208	31.283
2005	54.635	31.851
2010	64.152	32.649
2015	74.871	33.724
2020	86.247	35.068
2025	97.182	36.554
2030	107.89	38.479
2035	118.36	40.367
2040	128.431	42.617
Adj Factor	1.058477	1.019362